The Golden Age and Decline of Islamic Civilisation

S.E. Al-Djazairi

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INTRODUCTION

Muslim civilisation sprang into existence soon after the birth of Islam (7th century C.E). It lasted for a large part of the middle Ages, and began to collapse in the 13th century following the loss of the centres of Islamic power and civilisation: Cordova (1236), Valencia (1238), Seville (1248), and Baghdad (1258), all fell in the space of few decades to invading forces. During the same period, in 1260, Damascus and other Syrian towns and cities, core centres of Islamic civilisation, also fell to invading Mongol hordes, completing a chain of disasters. On the particular impact of the Mongols, Saunders says, that, in Baghdad, in 1258, the palaces, colleges and mosques were plundered and burnt; the cultural accumulation of five centuries perished in the flames, and the appalling figure of 800,000 is the lowest estimate given of the number of men, women and children who were slaughtered in the streets and houses.[1] The Christians gathered in a church under their patriarch were spared.[2] Glubb outlines the event further:

> 'On 10th February (1258), the Khalif Mustassim gave himself up. Hulagu ordered him to instruct the whole population to gather on the plain outside the walls, where they also were shot, slashed and hacked to death in heaps, regardless of age or sex. Not until 13th February did the Mongols enter the city. For a week, they had been waiting on the walls, not a man daring to leave his unit to plunder. Such iron discipline, unknown in the Middle Ages, goes far to account for their invincibility. The city was then systematically looted, destroyed and burnt. Eight hundred thousand persons are said to have been killed. The Khalif Mustassim was sewn up in a sack and trampled to death under the feet of Mongol horses.'

Glubb concludes:

> 'For five hundred years, Baghdad had been a city of palaces, mosques, libraries and colleges. Its universities and hospitals were

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[1] J. J. Saunders: *A History of Medieval Islam* (Routledge, London; 1965), p. 181.
[2] Ibid.

the most up to date in the world. Nothing now remained but heaps of rubble and a stench of decaying human flesh.'[3]

Syria and Palestine, once thriving regions, famed for their trades, culture and scholarship, suffered a similar fate at the hands of both Mongol and crusaders. Jerusalem's flourishing character prior to the crusades is noted by the traveller Nasr Eddin Khusraw in 1047. There, he notes things were cheap and plentiful, beautiful markets and high buildings everywhere, a great number of craftsmen, and each craft with its market.[4] About a hundred thousand people lived in the city, which also had a great hospital with rich waqfs (endowments) dedicated to it, from which medicines for its numerous patients are dispensed and salaries for doctors were paid, and where medicine was taught.[5] In this same 11th century, under the Seljuks, just on the eve of the crusades, Jerusalem sheltered a great variety of cultural activities. Great scholars from both east and west of the Muslim land made the city their destination, many settling there; both the city's scholars and the visitors participated in a rich cultural life.[6] Ibn al-Arabi gives a vivid picture of such activities in the city, a meeting place of scholars from Khurasan in the east to Al-Andalus (Muslim Spain) in the west, the author was impressed by the majlis (study circles) and scholarly disputations.[7]

When the crusaders arrived in July 1099, they inflicted on Jerusalem its worst woes in history. Storming through the city walls, they slaughtered the whole Muslim population. A contemporary, Abbot Raymond of Agiles of the French town of Du Puy, present during the dramatic moments, wrote with glee:

> 'When our men took the main defences, we saw then some astonishing things amongst the Saracens. Some were beheaded, and that's the least that could happen to them. Others were pierced through and so threw themselves from the heights of the walls; others after having suffered at length were thrown into the flames. We could see in the roads and in the places of Jerusalem bits and pieces of heads, hands, and feet. Everywhere we could only walk through cadavers. But all that was only little…' The abbot's description moves onto the Mosque of Omar, where: 'there was so much blood in the old temple of Solomon that dead

[3] J. Glubb: *A Short History of the Arab Peoples (*Hodder and Stoughton, 1969), p. 207.
[4] Nasir Khusraw in A.A.Duri; Jerusalem in the early Islamic period; 7th-11th centuries; in *Jerusalem in History;* Edited by K.J. Asali (Scorpion Publishing Ltd, 1989), pp. 105-29; at pp. 118-9.
[5] Ibid.
[6] A.A. Duri: *Jerusalem;* op cit; p. 119.
[7] Ibid; p. 120.

> corpses swam in it. We could see hands floating and arms that went to glue themselves to bodies that were not theirs; we could not distinguish which arm belonged to which body. The men who were doing the killing could hardly bear the smoke from the corpses.'[8]

The same scale of crusader slaughter and devastation was inflicted on the remainder of the East,[9] much of this devastation is described in the third part of this work. Whatever escaped the crusaders was devastated by the Mongols, who, from 1258 to the early 14th century, inflicted on Syria, Palestine and Iraq what their ancestors had earlier in the century (13th) inflicted on other glories of Eastern Islam (Khwarizm, Bukhara, Merw, etc). Thus, briefly, Aleppo, a city rich in crafts and scholarship, no sooner had it recovered from the woes of the crusades under Imad Eddin Zangi (r. 1128-1146) and Nur Eddin Zangi (r. 1146-1174),[10] was devastated by the Mongol hordes. Thrice occupied by the Mongols during the 13th century, the city was reduced to destitution. In 1260 the citadel, the walls, the grand mosque, and surrounding structures were destroyed. The population was systematically slaughtered. In 1280, mosques, madrasas, the houses of emirs, and the sultan's palace were pillaged and burned.[11] One hundred thousand young women and children were taken as slaves, the remainder of the inhabitants were systematically exterminated.[12]

The sharp decline of the Syrian population illustrates the impact of centuries of Crusader and Mongol invasions.[13] At the time of the Frankish invasion the

[8] Abbot Raymond of Agiles; in G. Le Bon: *La Civilisation des Arabes* (Syracuse, 1884), p. 249.
[9] G.W. Cox: *The Crusades* (Longmans, London, 1874).
Sir Steven Runciman: *A History of the Crusades*, 3 vols (Cambridge University Press, 1962).
J. J. Saunders, *A History*; op cit.
[10] A.M. Edde: Alep; in *Grandes Villes Mediterraneenes du Monde Musulman Medieval;* J.C. Garcin editor; (Ecole Francaise de Rome, 2000), pp. 157-75; at p. 157.
[11] I.M. Lapidus: *Muslim Cities in the Later Middle Ages* (Harvard University Press; Cambridge Mass; 1967), p. 14.
[12] J. Glubb: *A Short History*; op cit; p. 207.
[13] Y. Courbage, P. Fargues: *Chretiens et Juifs dans l'Islam Arabe et Turc* (Payot, Paris, 1997), p. 35.

country's population stood at 2.7 million inhabitants;[14] two centuries on, despite a revival under the Mamluks, in 1343, it stood at only 1.2 millions.[15]

In Spain, equally, the 13th century was a century of terrible Islamic losses. In the space of a few years, all the great centres of Islamic learning and civilisation were lost, and for ever, by Islam: The Balearic Islands between 1229 and 1235, Cordova, the once mighty capital, in 1236, Valencia in 1238, Murcia in 1243-4, Jaen in 1246, Seville, in 1248, Tarifa, finally, in 1275-6, completing a chain of losses which only left Grenada in Muslim hands. Read offers vivid, albeit brief, extracts of destruction and slaughter that followed each conquest of Muslim towns and cities by Christian forces.[16] More details are given by Scott[17] and Lea.[18] It was the rule that Muslim defeat was subsequently followed by mass slaying of Muslims, and the loss of Muslim economic, social, cultural, and of course, political power.[19] Cordova at its fall was full of eager Christian land-hunters who seized Muslim farms in the hinterland and drove off the inhabitants.[20] On the Island of Minorca, all but one hundred Muslims, were allowed to remain, the rest of the population was rounded up and sold into slavery, temporarily glutting the markets of Ibiza, Valencia and Barcelona.[21] The remaining Muslims had to wear a distinctive garb, and were forced to live in a separate section of each city,[22] or were regularly moved en masse within Spain whenever the occasion arose; in 1247 James I, for instance, ordering their expulsion from Aragon. Over 100,000 of them left.[23] Those able to maintain their trades were heavily taxed.[24] In Aragon they paid tribute in money, in kind, or in service, their taxes double what could be exacted from

[14] J. Cox Russell: late Ancient and Medieval Population, Transactions of the American Philosophical Society, vol. 48/III, 1958, in Y. Courbage and P. Fargues: *Chretiens*; op cit; p. 35.
[15] A.N Poliak: The Demographic Evolution of the Middle East: population trends since 1348, Palestine and the Middle East, vol X. no 5, 1938; in Y. Courbage-P. Fargues: *Chretiens*; op cit; p. 35.
[16] J. Read: *The Moors in Spain and Portugal* (Faber and Faber, London, 1974).
[17] S.P. Scott: *History of the Moorish Empire in Europe*; 3 Vols (Lippincott Company; Philadelphia and London; 1904).
[18] H.C. Lea: *The Moriscos of Spain* (Burt Franklin, New York; 1901), 1968 reprint.
[19] T.B. Irving: Dates, Names and Places: The end of Islamic Spain; in *Revue d'Histoire Maghrebine;* No 61-62; 1991; pp 77-93; at p. 81.
[20] F. F. Armesto: *Before Columbus* (MaCMillan Education; London, 1987), p.64.
[21] Ibid; p.36.
[22] W. Durant: *The Age of Faith* (Simon and Shuster, New York; 1950), p.700.
[23] Ibid.
[24] Ibid.

the Christians.[25] Thus, in the 13th century, the might, power and glitter of Muslim Spain was gone, and only survived in the enclave of Grenada for another two centuries, and then, all Muslim presence on the Peninsula was extinguished in 1609-10.[26]

The permanent loss of Spain in the 13th century, with the exception of the Grenada enclave, following the loss of Sicily in 1089, together with the combined Mongol-Crusader onslaught in the East left no great Islamic centre of civilisation intact or in Muslim hands with the exception of Cairo. Total warfare, invasions, mass slaughter and destruction, lasting over two centuries, annihilated the Islamic scientific structures and the foundations of civilisation built in previous centuries. Scholars were slain en masse, madrasas and libraries were ransacked; hospitals were turned into ruins; dams, bridges, and irrigation works were devastated, whole towns and cities were erased from the surface of earth, and trade was mortally disrupted.

As the Muslim world endeavoured to regain its high status in scholarship and civilisation, further woes befell it. In the late 14th century, Timur erupted from the east, and with his hordes, literally razed to the ground anything that had escaped crusaders and Mongols: schools, hospitals, irrigation works, dams… besides slaughtering millions from India to the Syrian coast.[27] Many regions, once thriving Islamic lands, are today as deserted and ruined as Timur left them seven centuries ago. After Timur, places such as Syria never regained their might, arts, crafts, or scholarly magnificence.

From the 13th until the 18th century, European pirates devastated the city ports of North Africa down to Egypt, crippling trade severely; whilst the Portuguese laid waste Islamic trade in the Indian Ocean.[28] Spain and Portugal had also begun their advance and conquest of North Africa (late 15th-early 16th century), and only Ottoman intervention checked these advances.[29] Soon, though, in the late 18th, the land of Islam began to

[25] Sandoval, Lib.xii, & xxviii. In H.C. Lea: *A History of the Inquisition in Spain;* 4 vols (The Mac Millan Company, New York, 1907), vol 3; p. 343.
[26] R de Zayas: *Les Morisques et le racisme d'etat* (Les Voies du Sud; Paris, 1992).
[27] E. Gibbon: *The Decline and Fall of the Roman Empire* (W. Smith; London, 1858), Vol VII; 1920; as in pp. 55-6.
[28] W. Heyd: *Geschichte des Levantehandels im Mittelalter*, 1879. Fr ed: W. Heyd: *Histoire du Commerce du Levant au Moyen Age* (Leipzig; 1885-6; reedit; Amsterdam 1967), vol 2, in particular.
[29] A C. Hess: *The Forgotten Frontier* (The University of Chicago Press, Chicago and London, 1978).

gradually fall into colonial hands, beginning with Mughal India, the central Asian lands, south eastern Europe, etc. When Ottoman power declined further in the 19th and early 20th, the once mighty lands of Islam, one place after the other, fell to colonial Europe. After that, Islamic power and the light of Muslim civilisation dimmed to a flicker.

Before the 13th century, and straight from the birth of Islam (7th century), the Muslims experienced upheavals of all sorts: assassinations, localised wars, epidemics and so on. However, such chaos was contained, and losses were never as grave as in the 13th century. Never before had the foundations of Islamic civilisation, trade, libraries, institutions of learning, economic infrastructure… suffered widespread destruction on a scale comparable to that of the 13th century and after. The centres of power and civilisation: Baghdad, Cordova, Seville, Murcia, Farghana, Herat, etc, where most scholars came from during the 'golden age' (7th-13th century), had all stayed in Muslim hands. In the 13th century, however, all these places were lost to Islam, some (Cordova, Seville, Valencia, Murcia, etc.) for ever. The others (Aleppo, Baghdad, Merw, Khwarizm, Nishapur, etc) were devastated beyond recovery, some such great centres of eastern Islam were erased from existence to this day by the invaders.

Foreign invasions are not alone to blame, though. Corrupt Muslim rulers and elites also accounted considerably for the decadence of Islamic power. Hence, as Scott points out:

> 'The character of the Mussulmans of Spain was defiled by all the vices which follow in the train of prodigal luxury and boundless wealth. Among these drunkenness was one of the most common. Personages of the highest rank were not ashamed to appear in public while intoxicated… National degeneracy early indicated the approaching and inevitable dissolution of the empire. The posterity of the conquerors, who in three years had marched from Gibraltar to the centre of France, became in the course of a few generations cowardly, effeminate, corrupt.'[30]

And what was proper to Spain was also the case in the Abbasid court; the Caliph supposed to defend the city against the Mongols had a harem of 700 women and slave girls, and a thousand eunuchs to serve them.[31] The

[30] S.P. Scott: *History*; op cit; Vol II, at pp. 648 and 650.
[31] Baron G. d'Ohsson: *Histoire des Mongols*; La Haye et Amsterdam; 1834; Vol 3;Vol 3; 240.

Caliph was trampled under Mongol horses, a symbol of decadence of the Caliphate.

In face of all such woes, only the timely intervention of the Mamluks, first, from the 13th century, and the Ottomans, between the 14th and 19th centuries, kept the Muslim realm safe from total collapse. Then, once Ottoman power collapsed, from the 19th century onwards, Islamic civilisation lost its last centre of power.

****

Before it collapsed, Muslim civilisation was able to register remarkable achievements. Its legacy is visible in great architectural works, modern sciences and learning, trigonometry; surgery, optics, the Arabic numerals, star names, gardens and gardening, hospital care; university learning, early knowledge of India, China and Scandinavia, etc. It was not just Arabs or Muslims who were involved in this great legacy, but all ethnic groups and faiths. Islamic civilisation was the one and only truly universal civilisation that has ever existed in the history of humanity. The Islamic policy of inclusion went along with other manifestations of the same nature; medical care, as an example, was afforded to all, and so was education, and even power, at the highest echelons, was open to non-Muslims.

It is these dominant aspects of Muslim civilisation, its rise, stature, accomplishments, and subsequent decline, which are looked at in this work. These are also matters, which Western scholarship has also looked at for decades, if not centuries. This work, however, is very much critical of such Western scholars, and it is this criticism which is the focus of this work. Western scholarship on the whole is indeed guilty of misrepresentations and distortions of Islamic civilisation. It is, for instance, ever keen to describe Islamic civilisation as a mere reproduction of other civilisations, the Greek above all. It is also keen to demean Islamic accomplishments when it does not entirely suppress them from knowledge. Amongst Western scholarship it is customary to find the same facts, names, arguments, and worse, the same errors repeated in a wide variety of works. Crucial matters are hardly, if ever, developed beyond a few words as if they were mere trivialities, whilst trivialities are dwelt upon ad nauseam. As this work also shows, whilst older Western

gradually fall into colonial hands, beginning with Mughal India, the central Asian lands, south eastern Europe, etc. When Ottoman power declined further in the 19th and early 20th, the once mighty lands of Islam, one place after the other, fell to colonial Europe. After that, Islamic power and the light of Muslim civilisation dimmed to a flicker.

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historians of Islam and its civilisation, despite their shortcomings, contributed greatly to the understanding of Islamic civilisation,[32] their modern counterparts, on the whole, are abysmally lacking in every intellectual dimension. Reading through some works on the history of science and civilisation can be extremely frustrating; the space devoted to the Islamic role is negligible.

One major deficiency this work tackles relates to the generalised assertion that Islamic science is Greek, or derives from the Greek legacy. In this work it will be demonstrated, instead, that it was Islam, the faith, which was, in fact, at the source of all Islamic sciences and accomplishments, and that Greek science was only a tool, a means, just as others were, such as the Hindu, and above all the Chinese legacy, and that most of the basic manifestations of Islamic civilisation have no Greek antecedent of any sort.

This book will not specifically address the issue of the Islamic impact on the Christian West, but will touch upon it in many instances, showing how Islamic learning was transferred to the Christian West. In doing so, this work will highlight one particular inanity generalised amongst Western history that the science and learning the Christian West recuperated from Islam (in the 12th century, above all) was Greek, and the reason why it was recovered in Arabic was because 'Greek science had been lost to the Christian West, and was recuperated in Arabic from its Muslim guardians.'[33] Yet, we also find that whenever there was any revival elsewhere, or any other time in the Christian West, it was due to the Greek

[32] It is not, indeed, in the generally drab writing of today that one can find the quality of information as can be found in works such as:
-W. Heyd: *Histoire du Commerce du Levant* (A.M. Hakkert; Amsterdam; 1967).
-L. Leclerc: *Histoire de la Medecine Arabe*; 2 Vols (Paris, 1876).
-A. Mieli: *la Science Arabe et son role dans l'evolution scientifique mondiale* Ed, (Leiden, Brill, 1938).
-J. Ribera: *Dissertaciones y opusculos*, 2 vols (Madrid, 1928).
-G. Sarton: *Introduction To the History of Science*, 3 Vols, (Carnegie Institute; Washington; 1927-48).
-L. Sedillot: *Memoire sur les Instruments astronomiques des Arabes* (Paris, Imprimerie Royale; 1844).
-R. Briffault: *The Making of Humanity* (George Allen, London, 1928).
-J.W. Draper: A *History of the Intellectual Development of Europe (*George Bell and Son, London, 1875).

[33] Such as the SOAS historian appearing on the BBC program: An Islamic History of Europe, Broadcast on BBC4, 10 April 8.30 p.m, seen by this author.
Or any work, and so common an assertion it was found on the covers or back covers of books, such as in R. Fletcher: *Moorish Spain* (Phoenix; London; 1992), back-cover.

legacy. Hence, in this latter respect, we learn, for instance, 'that the mother of all Western universities, Salerno in southern Italy, owes this status thanks to the Greek legacy; that Sicily played its leading role in the rise of modern science and civilisation, again thanks to its Greek heritage, that Amalfi, also in the south of Italy, did the same, that the later Renaissance (16th century) was due to the flow of Greek learning to the Christian West from deceased Byzantium (following its taking by the Turks in 1453), and so on and so forth.'[34] Hence, we have two contradictory arguments held by nearly every single Western historian, that on one hand Greek learning was lost to the Christian West, which explains its recovery from Arabic, and on the other, that such Greek learning, in its pristine Greek form, was responsible for the flowering of science and civilisation, whether before the 12th century, or after, or during the 16th-17th century Renaissance.

This work will particularly dwell on one central issue, that has already received the bulk of attention in this introduction, the matter of decline of Muslim civilisation. It will show that whilst Islamic sciences and other aspects of Islamic civilisation find some support amongst Western historians (a minority), overwhelmingly, Westerners, just as most non Westerners with secular or non Islamic leaning, blame Islam as the main source of decline of Muslim civilisation, setting aside all factors already looked at above. This is the principal source of contention this work has with such Western and Western inspired scholarship.

Before it deals with this issue, in its third and final part, this work, in its first part, offers an overview of Islamic civilisation. This part considers trade and industry; the urban character of Islamic society, as well as Islamic gardens, and touches on general aspects of Islamic scholarship. The second part will focus on Islamic sciences. The final part will dwell on the role of Islam as a faith in Islamic civilisation, and debate fully the matter of decline of such civilisation. Then as it deals with these principal

[34] Such as in:
P. Duhem: *Le System du Monde* (Paris; 1914).
B. Lawn: *The Salernitan Questions* (Oxford At The Clarendon Press, 1963).
O. Pedersen: *Early Physics and Astronomy* (Cambridge University Press, 1974).
P. Chaunu: *European Expansion in the Later Middle Ages;* tr by K. Bertram (North Holland Publishing Company; Amsterdam; 1979).
D. J. Geanakoplos: *Medieval Western Civilisation, and the Byzantine and Islamic Worlds* (D.C. Heath and Company, Toronto, 1979).

aspects, this work focuses on the Western historical writing and teaching related to them, highlighting the shortcomings of their approach.

It is important to point out at this stage, that not everything, whether with regard to the descriptions of Islamic sciences and civilisation, or its historical (mis)treatment, will be covered in this work. Space, time, and above all this author's limited competence impose restrictions in dealing with all aspects of Islamic civilisation. This work will provide a number of references for a curious audience to fill the gaps. This study aims at an original approach, which can form the ground for crucial debates.

Finally, it is worth insisting, that although fundamentally critical of modern Western scholarship, and very much critical of organised historical teaching today, this work is still witness to the ability and intellect of the tens of Western scholars, amongst the older generations, in particular. Without such historians, and what they have salvaged in terms of Muslim heritage, and their interest in the subject, this work would have never been possible. And whatever disagreements exist with them on some issues, gratitude and respect for their achievements surpass other considerations.

*All dates in this work are C.E.

PART ONE

ISLAMIC CIVILISATION AN OVERVIEW

'Muslim society, in its golden age, from the end of the ancient empires to the emergence of the modern states, was a melting pot in time and space, a great crossroads, a vast synthesis, an amazing meeting place.'[35]

These few lines capture Muslim civilisation in its thoroughness and in its role in human civilisation as this work will attempt to do. In this first part, in three chapters, it looks at the Islamic economic system, its urban setting, its gardens and its scholarship over its period of glory, from the 7th to the 13th centuries. The aim is to capture the wider picture of Islamic civilisation in its diversity, but above all bring in new arguments. There is thus no need to dwell too long and look at it from as many new angles as possible; to shed light, of course, on what other works have dealt with in great abundance. These works will be referred to as much as possible. This work will focus on those matters little touched upon elsewhere, and yet, whose role was vital to the evolution of Islamic civilisation, and the evolution of civilisation as a whole. This part, like others, will deal with the other central theme in this work: mainstream Western historical mistreatment of Muslim civilisation. It will raise this issue in relation to some (impossible to deal with all) of the aspects dealt with in the first two chapters, trade and industry, and urbanism. This issue of historical mistreatment is not discussed in the chapter on Muslim scholarship, for it will be abundantly dealt with in the subsequent part on sciences.

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[35] M. Lombard: *The Golden Age of Islam*; tr. J. Spencer (North Holland Publishers; 1975), p.239.

One

TRADE AND INDUSTRY

In this chapter are highlighted aspects of Muslim trade and Industry, beginning with one of the greatest fallacies related to the subject: the Pirenne Theory.

1. The Pirenne Theory:

In the early 1930s, Pirenne held in his *Muhammad and Charlemagne* that the advance of Islam led to the collapse of economic activity around the Mediterranean, thus driving Europe into the dark ages.[36] In more detail, his view was:

> 'European civilisation formed around the Mediterranean by the successive work of Egypt, Syria, Phoenicia, Greece and Rome. The latter, the last worker of an admirable labour, has brought into one single state all the people it inherited. The empire founded by Rome, including all, is thus an Empire that was essentially Mediterranean.'[37]

Pirenne goes on:

> 'From Byzantium, Asia Minor and Egypt merchants, Jewish, but mostly Syrian continued their supply of it (the West) with luxury goods, rich cloth, and fine wines. By their intermediary it received

[36] H. Pirenne: *Mohammed and Charlemagne* (F. Alcan; Paris-Bruxelles; 1937).
[37] H. Pirenne: Mahomet et Charlemagne, *Revue Belge de Philosophie et d'Histoire* 1, 1922, 77-86, in *Bedeutung Und Rolle des Islam Beim ubergang Vom Altertum Zum Mittelalter*, Paul Egon Hubinger: ed (Darmstadt, 1968), pp. 1-9. p. 1.

> the gold that was necessary for its currency and the papyrus that was used by copyists and clerks of chancelleries.'[38]

Until:

> 'The brusque irruption of Mohammedanism in the Mediterranean disrupts everything. Syria, once conquered in 633-8, stops sending to Marseilles ships and merchants; then Egypt falls under the yoke of Islam (638-40), and papyrus no longer reaches Gaul, and as the Muslim invasion grows stronger, maritime traffic, once thriving, now crumbles.'[39]
> 'The apparition of Islam brings to an end the use of gold as a currency; causes an end to the import of oriental textiles, an end to the use of papyrus, and puts a stop to the arrival of spices.'[40]

Thus:

> 'The Islamic invasion of the Mediterranean, to my opinion, is the event to which must be attributed the crack which separates Antiquity of European history from that which we usually call the Middle Ages. In shutting the sea and in cutting the West from the Orient, it put an end to the Mediterranean unity, which had constituted for thousands of years the most striking character, and the condition itself of traditional development of civilisation in that part of the world.'[41]

For Pirenne, the arrival of Islam did not just destroy the Europe of Antiquity, and cause the end of the Mediterranean community which had survived the Roman Empire, worse, 'The sea, once familiar and familial, around which all came together, now becomes alien and hostile.'[42]
The effects of Islam go even further:

> 'The Barbarian invasions altered nothing, but now, the very countries where civilisation was born, are wrested away, and the cult of the Prophet is substituted to the Christian faith, Muslim law to Roman law, Arabic to Greek and Latin... Of the maritime traffic of before we lose all traces.'[43]

Pirenne's theory became and remained a convenient foundation for his followers to see in the Islamic advance of the 7th-8th century an explanation to Europe's centuries or so of darkness (5th-15th), and

[38] Ibid; p. 7.
[39] H. Pirenne: Un Contraste Economique; Merovingiens et Carolingiens, Revue Belge; 2, 1923, 223-35. in *Bedeutung Und Rolle des Islam*; pp. 10-22; p. 16.
[40] Ibid.
[41] Ibid; p.10.
[42] H. Pirenne: Mahomet et Charlemagne; in *Bedeutung*; op cit; p. 8.
[43] Ibid; p. 9.

identifying Islam with chaos. Pirenne, as result, rose to the status of remarkable man of learning.[44] For Wiet et al, for instance, 'Reference must be made here to the views brilliantly put forward by the great Belgian historian Henri Pirenne.'[45] Pirenne had been 'spreading the good word,' Coville says,[46] delivering lectures world wide, explaining how it was Islam, instead of the 'Barbarian' invasions of three centuries before (late fifth CE) that had broken a hitherto cohesive and prosperous civilization.

Pirenne's theory was flimsy, though, mainly based on the fact that imports of gold and papyrus had 'disappeared' during the Islamic advance, and so his theory could not stand in front of robust challenges. Such challenges came from a number of directions, such as from those who were in agreement with Pirenne with regard to economic regression in the Merovingian period, but who do not accept that the domination of Islam on the Mediterranean basin was the main cause of the phenomenon.[47]

Further challenges completely unseated Pirenne's argument. Perroy outlines the main defects of Pirenne's theory by demonstrating that Islam as a faith had no problem with trade, but quite the contrary. The Prophet was a trader; his followers crossed the world from The Sudan to the Volga, from China to Madagascar to trade; and it was, in fact, Islam that awakened Western trade[48] (more on which further on). Besides, Perroy explains, the decline of trade between East and West of the Mediterranean was anterior to Islam, and in the period in question, the 8th century, Byzantium kept up its trade with its possessions in Southern Italy and the Adriatic. Moreover, if there was little traffic beyond that narrow area, it was due to internal conditions within the West and to the monopolistic policies pursued by Byzantium.[49] Perroy, finally, notes, that the passage from gold to silver between 650 and 700 is neither a sign of the collapse of civilisation as believed by Pirenne, nor it is a definitive exhaustion of the stocks of gold of the Occident.[50]

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[44] Hence, on May 18, 1938, in his honour, was held in Brussels (Belgium), a solenal academic session, which was attended by the Belgian king, Leopold II.
[45] G. Wiet et al: *History of Mankind;* Vol 3: *The Great Medieval Civilisations*; Tr from the French (George Allen & Unwin Ltd; UNESCO; 1975), p.5.
[46] A. Coville: Les Commencements du Moyen Age d'apres Henri Pirenne, *Journal des Savants,* 1938, pp. 97-104, at p.97.
[47] Pierre Lambrechts: Les Theses de Henri Pirenne sur la fin du monde Antique et les debuts du Moyen Age, in *Bedeutung*; op cit; pp 32-57; p. 34.
[48] E. Perroy: *Le Moyen Age* (Presses Universitaires de France, 1956), p.113-4.
[49] Ibid.
[50] E. Perroy: Encore Mahomet et Charlemagne. Revue Historique 212, 1954, 232-8, in *Bedeutung*; op cit; pp. 266-75, at p.267.

Dennett, too, notes[51] how Pirenne asserts that 'It is a proven fact that the Musulman traders did not install themselves beyond the frontiers of Islam. If they did trade, they did so among themselves.'[52] This statement is a serious misrepresentation of fact, Dennett says. Referring to Heyd, he explains that Muslim merchants had established trading colonies in India, Ceylon, East Indies, and even China by the close of the 8th century.[53] A wide geographical spread, which will be object of focus further on.

Further defects of the Pirenne theory were raised by Lopez, Bolin, Dennett again, Lombard and Genicot.[54] Lopez points out that gold did not become scarcer after the Muslim advance. On the contrary, in the 8th century and after, both Muslim coins and their imitations seem to have been fairly common.[55] The abandonment of the gold standard after Louis the Pious, Lopez explains, was not directly connected with the Muslim irruption, but was due to the insufficient prestige of the Western monarchs.[56] Lopez also refers to Sabbe (an earlier follower of Pirenne) to highlight that the trade in Oriental purple-dyed and embroidered cloths was never interrupted in Western Europe, and the diminished use of Oriental cloths among the laymen (if there was a diminution) was largely due to fashion change. The Church did not change fashions, and, in fact, the largest part of the existing evidence of Oriental cloths in Western Europe relates to the Church.[57]
On the currency front, Bolin, referring to Heyd,[58] points out that beyond any doubt silver was exported from the Muslim world to Western Europe, and spices and oriental luxury goods of various kinds were equally imported into Western Europe just as during an earlier period.[59] The flow of silver was considerable, which demonstrates very strong trade links with Islam. Bolin points to the huge coin hoards from northern and eastern Europe, their geographic distribution from Norway and northern Sweden in the north as far as Silesia and the Ukraine in the south, from Schleswig-Holstein and

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[51] D.C. Dennett: Pirenne and Muhammad; in *Bedeutung*; op cit; pp. 120-59; at p. 125.
[52] H. Pirenne: *Mohammed and Charlemagne*; op cit; p. 174.
[53] See W. Heyd: *Histoire du commerce*; op cit; vol 1; p. 28.
[54] For an excellent summary of articles devoted to the thesis and its criticism see *Bedeutung op cit;*.
[55] Cf. Bloch, p.13 ff., with bibl in Robert S. Lopez: Mohammed and Charlemagne: A Revision. Speculum 18, 1943, 14-38, in *Bedeutung*; op cit; pp. 65-104. p.92.
[56] Cf. especially G.I. Bratianu, *Etudes Byzantines d'histoire economique et sociale* (Paris, 1938), p. 219 ff.; also Bloch, pp.25-28; R. S. Lopez: Mohammed; p.98.
[57] Cf. Sabbe, op cit, in R. S. Lopez: Mohammed; p. 99.
[58] W. Heyd: *Geschichte des Levantehandels im Mittelalter* 1, p. 104 ff.
[59] S. Bolin: Mohammed, Charlemagne and Ruric: *Scandinavian Economic History Review*, Vol, I, 1953, pp. 5-39, in *Bedeutung*; op cit;. pp. 223-265.

Mecklenburg in the west to the Urals in the east.[60] These hoards are in the hundreds, and were very large, 'treasures troves such as Aladdin's cave;' one find consisting of more than 11,000 dirhems, in addition to an indeterminate number of fragments, and weighed more than 65lbs.[61] Bolin, in fact, demonstrates a parallelism of evolution between Europe and the Muslim world, specifically on the monetary level, which would have been incomprehensible if there had not been important East-West relations, especially via the North Sea.[62]

With regard to the particular issue of papyrus, Dennett counters Pirenne, explaining:

> 'Since the Arab conquest of Egypt did not cut off the supply of papyrus at its source, because this material was still found in Gaul a century later and was regularly employed by the Papacy until the eleventh century, it is difficult to say that its disappearance in Gaul is a conclusive proof that the Arabs had cut the trade routes. In the absence of all direct evidence one way or another, it would appear that as a possible hypothesis one might conclude that because parchment could be locally produced, because it was preferable as a writing material, and because, owing to a depreciated coinage, it may not have been more expensive than papyrus, the people of Gaul preferred to employ it.'[63]

With regard to Pirenne's view that the Muslim arrival caused trade to collapse, Lombard takes the very opposite position, and affirms that the Muslim advance, occurring at a time of exhaustion in Europe, re-established and amplified international commerce and contributed to the recovery characterizing the Carolingian Empire, and that Muslim currency, in particular, infused new blood into commercial relations.[64] Lombard goes even further, holding that it was the Muslim advance that led to the West regaining contact with Oriental civilisation and, through the Muslims, with the major world movements in trade and culture. 'Whereas the great barbarian invasions of the fourth and fifth centuries,' Lombard holds, 'had caused an economic regression in the West under the Merovingian and

[60] European discoveries of Cufic coins to 1900 are listed in A. Markov: Topografiia kladovvostochnykh monet, 1910, in S. Bolin: Mohammed, in p.258.
[61] S. Bolin: Mohammed, p.258.
[62] S. Bolin: Mohammed, op cit.
[63] D.C. Dennett: Pirenne and Muhammad; op cit; at pp. 135-6;
See M. Prou: *Manuel de Paleographie Latine et Francaise* (Paris; 1892), pp. 171-90.
[64] M. Lombard: l'Or Musulman au Moyen Age, in *Annales ESC* (1947): pp. 143-60.

Carolingian dynasties, the creation of the new Islamic Empire brought with it an astonishing development in this same area.'[65]

Genicot, too, referring to Ganshof, notes that the ports of Provence (France) had not stopped their activity from the 8th to the 10th century,[66] and suggests that the decline of the exchange economy could have other causes than the Muslim irruption, especially he cites the state of anarchy of the Frank monarchy after Dagobert.[67] And, so Lopez concludes:

> 'If neither the 'disappearance' of papyrus nor that of gold currency is connected with a sudden regression in trade caused by the Arab conquests, the thesis of Pirenne has little support left.'[68]

Pirenne's theory is further undermined by the fact that historians who looked at the domestic history of Europe noted the decline taking place in the western portion of the Roman empire even earlier than the 5th century; thus centuries before Islam was even born. Lewis has even noted that Muslim control of the Mediterranean did not begin in the 7th or 8th century, as Pirenne stated, but in the late 9th and early 10th centuries;[69] a five century gap between Islam and European decline, which makes Pirenne's theory untenable.

Having laid Pirenne to rest, it is relevant to look at the multiple aspects of Muslim trade, not so much from a quantitative side, which has been examined by countless sources, but rather from the qualitative side, how Islam brought various and wide parts of the globe into a vast trading area; and how Islam provided the very foundations to modern trade as it stands today. But first, a word on industrial production to shed some light on the traded goods and to provide a wider image of the Islamic industrial setting that is missing in modern works, most particularly.

[65] M. Lombard: Quand l'Islam Brillait de Mille feux. The article appeared in *Le Temps stratégique* No 20, Spring 1987; but can be found at http://www.archipress.org/batin/ts20lombard.htm.
[66] F.L. Ganshof, *Note sur les ports de Provence du viii au x siecle,* in *Revue Historique*, t. CLXXXIV, 1938, p. 28. in L. Genicot: Aux Origines de la civilisation in *Bedeutung*; op cit; pp. 105-19. p.106.
[67] L. Genicot: Aux Origines de la civilisation... pp 105-119.
[68] R. S. Lopez: Mohammed; op cit; pp 97-8.
[69] A.R. Lewis: The Moslem Expansion in the Mediterranean, A.D. 827-960: pp 23-9 in *The Islamic World and the West*; Ed: A. R. Lewis (John Wiley and Sons; London, 1970), p.23.

2. Industry:

Robert Wright, commenting on Landes, holds that:

> 'Landes spent part of his magnum opus *The Wealth and Poverty of Nations* trying to figure out why the westernmost of Oriental cultures, the Islamic civilisation of the Middle Ages, had not been destined for industrial greatness. His answer, in part: short time horizons. Whereas Europe's pragmatic medieval Christians coolly pursued 'continuing, sustainable profit,' the rampaging Muslims were propelled by 'fighting zeal' and paused 'only for an occasional digestion of conquest and booty.'[70]

This view of Muslims as looting hordes, incapable of organisation of any sort, is, once more, generalised to Western scholarship, and is reinforced by the dominant misrepresentation in historical writing and teaching that industry is a modern, 18th century, Western phenomenon. The English 'Industrial Revolution' of the 18th century is deemed to be the first model of goods produced for a mass market, machine power playing a central role, together with large-scale capital investment through banks and other financial institutions, and a class of entrepreneurs working towards meeting the needs of an increasingly urban population. This generalised view is contradicted by historical reality on three main grounds.

Firstly, there is nothing such as a sudden revolution, as in this instance, the English spontaneously discovering, building, and installing on the ground machinery, warehouses, financial and legal institutions, regulating enterprises and entrepreneurs, and so on and so forth. Things took centuries to reach such a state of development, and even then, they had to keep being adjusted and improved for decades, and even a century or more after.

Secondly, rather than industry being hampered by Islam, it was quite the contrary, from its inception, Islam promoted industrial organisation, wage labour, and private property. With regard to the latter, for instance, the Qur'an shows no hostility to private property, since it lays down rules for inheritance.[71] The Prophet's tradition is full of praise for those who

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[70] R. Wright: Nonzero: The Logic of Human destiny, at: http://www.nonzero.org/asia.htm
[71] M. Rodinson; *Islam and Capitalism;* tr by R. Pearce (Allen Lane; London; 1974), p. 14.

engage in enriching themselves so as to be able to help the deprived.[72] Similarly, wage labour is seen in Islam as something perfectly normal; it being a particular case of hiring; one hiring a man's labour power just as one hires a boat or a house.[73] If a man repairs a wall that is collapsing, he has a right to be paid a wage.[74] The only restrictions in Islam derive from moral, religious, and principles of juridical order.[75]

Thirdly, looking through the history of early Islam, reveals the existence of a powerful industrial sector geared for mass production. Medieval Muslim geographers speak and describe chief centres of cotton manufacturing in Basra, Khurasan, Herat, Dimyat, Nishapur and Rayy; linen cloth production in Basra, Khurasan and Tinis, centres for silk production to be found in Khuzistan, Bukhara and Fars; preparation of perfumes in Fars and Iraq; paper production in Syria and Transoxianan, and varied forms of industrial production elsewhere.[76] Islamic manufacturing, as will be amply shown in the following outline, also produced for a mass urban market and for exports, and relied on the extensive use of power to activate machinery. Banks and other financial institutions, state administration and its legal apparatus, also played their part in stimulating industrial production in much the same way as we have today. The use of Letters of Credit, for instance, was widespread, and some cities operated stock exchanges which earned every day nearly 6,500 Dinars in rights of access.[77] Also, early in Islam, evidence shows the existence of wage labour, Tunisian lead miners of the 12th century, pearl fishers in the Gulf, sugar workers in Egypt, etc, all receiving fixed wages for definite tasks.[78]

To highlight the Islamic pioneering role in the formation of an industrial basis on a modern model, the following outline expands on the role of some industries that had a multiplicity of impacts.

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[72] M. Hamidullah in *Cahiers de l'ISEA;* Supplement no 120; Series V; No 3; Dec. 1961; p.27.
[73] M. Rodinson: *Islam and Capitalism;* op cit; p. 16.
[74] Ibid; p. 14.
[75] As examples available in translation of how hiring, and especially wage labour, are dealt with in religious law, see, for instance, K. Ibn Ishaq: *Abrege de la loi Musulmane selon le rite de l'Imam Malek*; Tr. G.H. Bousquet; Vol III (Le Patrimoinel Algiers; 1961), pp. 128-33.
[76] S.M. Z. Alavi: *Arab Geography in the Ninth and Tenth Centuries* (Aligarth; 1965), pp. 97 ff.
[77] Gerspach: *L'Art de la Verrerie* (A Quantin Imprimeur, Editeur; Paris; 1885), p.97.
[78] M. Rodinson: *Islam and Capitalism*; op cit; pp.52-3.

The Paper Industry:

Early Islamic paper making involved many modern industrial processes, such as mass manufacturing, the use of machine power, the of use of wind and water to activate such machinery, and industrial organization. It also anticipated the introduction of innovative processes in response to local conditions and resources, and the use of advanced marketing techniques.

The first paper workshop in Islam was established in Baghdad in the year 795.[79] It seems, though, that it was much earlier, after the conquest of Samarkand, in 704, that the Muslims came into contact with the Chinese and learnt the art of paper making.[80] Two years after, in 706, a certain Yusuf Amr of Makkah (Mecca) discovered the process of making paper from cotton.[81] The first paper mill in Islam was set up in Baghdad in 793-795. After Baghdad, paper manufacturing rapidly spread west to Damascus, Tiberias, Syrian Tripoli; the factories set up in Syria benefiting greatly from the favourable conditions for growing hemp.[82] The traveller Nasir I-Khusraw (fl. 1030s) said that Syrian paper was similar to that made in Samarkand, but of better quality.[83] High quality Hamawi (Hama-made) paper was used for important diplomatic and religious documents.[84] In general, Syrian paper was regularly shipped to Egypt as it was to the Red Sea ports, and India.[85] Paper production reached Egypt in the late 8th century, and the first extant Muslim document made of paper dates from the year 180 of Hijra (796 of our era) and comes from that country.[86] The earliest copy of the Qur'an on paper was recorded there in the 10th century.[87] There, in Egypt, paper was largely produced at al-Fustat, Fuwwa, and Fayyum. From Egypt, paper making travelled further west, to North Africa, and reached Morocco, sometime in the 9th-10th century. Fes, in the 12th

[79] G. Wiet et al: *History;* op cit; p.331.
[80] S.M. Imamuddin: *Muslim Spain* (Leiden; Brill; 1981), p.110.
[81] Carreres: Historia de Jativa; p. 48; L. Viardot: Historia de los Arabes y de los Moros de Espana; Barcelona; 1844; p. 239. in S.M. Imamuddin: *Muslim Spain*; p.110.
[82] M. Lombard: *The Golden Age of Islam*; tr J. Spencer (North Holland Publishers; 1975), p. 192.
[83] Nasir I-Khusraw: Tr. Schefer; pp. 41; and 58; n. 1 in M. Lombard: *Les Textiles dans le Monde Musulman du VII au XIIem Siecle* (Mouton Editeur; Paris; 1978), p. 203.
[84] T. Walz: Writing materials, in the *Dictionary of the Middle Ages*; Vol 12; J.R. Strayer Editor in Chief, (Charles Scribner's Sons, N. York, 1970 ff), at pp 697-9.
[85] Ibid.
[86] M. Lombard: *Les Textiles;* op cit; p. 203.
[87] M.Lombard: *The Golden*; op cit; p. 192.

century, was said to have 400 paper mills.[88] Like much else, from Morocco, paper production crossed the straight into Muslim Spain; the Andalusians, according to the geographer al-Muqaddasi (b. 946-d. end of 10th century), soon excelling at the craft.[89] The town of Jativa, near Valencia, became famed for its manufacture of thick, glossy paper, the *Shatibi*, following a process borrowed from the East.[90] According to the Sicilian based Muslim geographer Al-Idrisi (b.1099-1100- d. 1166), the paper of Jativa was of such good quality that the like of it was not to be found anywhere else in the world, and that it was exported to the East and the Maghrib.[91] There were also other places of paper production of the heavy, smooth, glazed sort.[92] And the same high quality of Andalusi paper is extolled to this day, Goitein thus remarking that a letter from Grenada, dated 1130, was written on the best paper, almost entirely white, strong, and pleasantly smooth.[93]

By the year 1000, it could be said that paper was in general use throughout the Islamic world, and this had a considerable impact on a wide variety of activities and industries. The new product replaced what hitherto were costly and also very rare materials for writing.[94] The advent of cheap and abundant paper fostered cultural activities and the industry of book production in the Islamic world.[95] Thus, whilst elsewhere, books were 'published' only through the tedious labour of copyists, hundreds, even thousands of copies of reference materials were made available throughout the Islamic land to all those wishing to learn.[96] Which, other than learning, stimulated the trade in books.[97] Markets of book makers and bookshops spread in the vicinity of the mosques.[98] The *Warraq* profession (waraq

[88] K. von Karabacek: *Das Arabische Papier, eine historich-antiquarische Untersuchung* (Vienna; 1887), p. 40.
[89] Al-Muqaddasi: *Ahsan at-taqasim fi Ma'rifat al-Aqalim*; is in M.J. de Goeje ed., (Bibliotheca geographorum arabicum, 2nd edition., Leiden, 1906), a partial French translation is by A. Miquel, (Institut Francais de Damas, Damascus, 1963). There are also English and Urdu versions of the work. Ref, here; Edition de Goeje, p. 239.
[90] On the paper making industry in Spain, see E.Levi Provencal: *Histoire de l'Espagne Musulmane*; Vol III (Paris, Maisonneuve, 1953), p. 185; and also C.E. Dubler: *Uber das Wirtschaftsleben (*Romania Helvetica XXII; Geneva; 1943), pp. 81-4.
[91] Al-Idrisi: Kitab; pp 192 and 233; in S.M. Imamuddin: *Muslim;* op cit; p. 111.
[92] E. Levi Provencal: *L'Espagne Musulmane au Xem siecle* (Paris; 1932), p. 185.
[93] S.D. Goitein: *A Mediterranean Society;* 5 vols (Berkeley; 1967-88), vol V; p. 288.
[94] G. Wiet et al: *History;* op cit; pp 331-2.
[95] Ibibd; p.331.
[96] M. Nakosteen: *History of Islamic Origins of Western Education:* 800-1350 (University of Colorado Press; Boulder; Colorado; 1964), p. 37.
[97] J. Pedersen: *The Arabic Book*; tr by G. French (Princeton University Press; 1984).
[98] Such as in Damascus, according to Ibn Battuta; I; pp. 207-8; in Fustat: Casanova: Foustat; XXXVIII-XL; in M. Lombard: *Les Textiles*; op cit; p. 205.

being the Arabic word for paper) developed widely and rapidly.[99] The *Warraqeen* (plural for Warraq) (paper maker) traded mostly in paper, (and quite often, copied manuscripts which they sold to customers.) The more established Warraqs went to considerable length to acquire new manuscripts.[100] Baghdad, most probably, became the first major city where the Warraqeen bookshops appeared.[101] And, from there, these shops spread to other parts of the Muslim world; Cairo, most particularly, became a major centre of the Warraqeen, where, according to Ibn Zulaq, during the Tulunid and Ikhsid rule of Egypt (868-969), there was a special bazaar for the Warraqeen where 'books were offered for sale and in its shops debates often took place.'[102]

There were major other outlets for mass production of paper. One such outlet was government; as early as the late 8th century paper was introduced to government offices by Harun al-Rashid's Vizier Ja'far.[103] This innovation did not just provide forms for authenticity of legal or governmental documents (as parchment previously used could be washed, whilst paper could not);[104] most of all it set a pattern with which other societies and countries would catch up centuries later. Good-quality papers were also used as gifts for sultans or as a material for currency; and as early as the 9th century, coloured papers were in use for a diversity of purposes: yellow, for instance, favoured in religious circles as it facilitated the memorization of the Qur'an.[105] Paper was also used for wrapping goods; in 1035, Nasir I-Khusraw, on a visit to Cairo, expressed his astonishment at seeing: 'sellers of vegetables, spices, hardware, provided with paper in which all they sold was immediately wrapped up.'[106] Literate traders also wrote extensively, and there have been found in Egypt remains of their registers, letters and contracts, the 10th century Geniza documents being nearly all on paper.[107] The same Geniza corpus showing the

[99] M. Sibai: *Mosque Libraries, A Historical Study* (Mansell Publishing Limited; London and New York; 1987), p. 41.
[100] Z. Sardar- M.W. Davies: *Distorted Imagination* (Grey Seal; London; 1990), p. 99.
[101] M. Sibai: *Mosque libraries*; op cit; p. 41.
[102] Ibn Zulaq, *Akhbar Sibawiy al-Misri*, pp. 33, 44 MS 1461; Tarikh Taimur, Egypt; in A. Shalaby: *History of Muslim Education* (Dar al-Kashaf; Beirut; 1954), p. 27.
[103] M. Lombard: *The Golden Age*; op cit; p. 191.
[104] Ibid.
[105] T. Walz: Writing materials, op cit; pp 698.
[106] In D. Hunter: *Papermaking: The History and Technique of an Ancient Craft* (Pleiades Books; London; 1943; 1947), p. 471.
[107] M. Lombard: *Les Textiles*; op cit; p.204.

widespread use of paper in books, legal documents, laundry lists, price inventories, and other items, mostly written on paper.[108]

The paper industry stimulated a variety of crafts and professions, which include dying, ink making, manuscript craftsmanship, calligraphy, etc. A number of sciences also progressed in the wake of the paper industry. Chemistry, obviously, has the most intricate links with the paper industry, Levey's articles on the subject in the review *Chymia* highlighting this. They deal with inks, glues, and erasure fluids, Islamic chemical technology.[109] Levey also draws attention to the pioneering works of the Tunisian, Ibn Badis (1007-1061), who in his *Umdat al-Kuttab* (Staff of the Scribes) in twelve chapters, writes amongst others on: the excellence of the pen, the preparation of types of inks, the preparation of coloured inks, the colouring of dyes and mixtures, secret writing, the making of paper, and so on.[110]

As noted above, there is nothing pioneering on the part of the Muslims in the invention of paper itself; a Chinese invention, like much else; the pioneering Muslim role, however, was in other ways. The Muslims adapted paper making to their specific local conditions, using local materials. They also fostered its development following methods that the industry has retained. The Chinese relied on fibre from the bark of the paper mulberry tree to prepare their material; but short of the substance, the Muslims innovated, using primarily linen as a substitute.[111] In fact, the principal materials which were used in paper making in the land of Islam were the linen of the Egyptian Delta and the Spanish Levant,[112] hemp from Samarkand, Spain[113] or Syria, the latter being of white colour and excellent quality, and mainly rags.[114] The use of the latter, rags, to considerable extent, was due to the widespread use of textile material for items of clothing. In Spain, generally, paper was manufactured from flax and rags.[115] Papers from Muslim manuscripts preserved in the libraries of Spain also show that

[108] O.R. Constable: *Trade and Traders in Muslim Spain* (Cambridge University Press; 1994), p. 195.
[109] In *Chymia*, Quarterly review devoted to the history of chemistry; edited by H.M. Leicester. University of Pennsylvania Press, Philadelphia; Volume 7; (1961).
[110] M. Levey: The Manufacture of inks, Liqs, Erasure Fluids and Glues-A preliminary survey in Arabic Chemical Technology; in *Chymia*; Vol 7 (1961), pp. 57-72.
[111] D. Hunter: *Papermaking*: op cit; p.139:
[112] M. Lombard: *Les Textiles*; op cit; p.205.
[113] *Ibn Awwam: Kitab al-Filaha* (Le Livre de l'agriculture), tr by Clement-Mullet; 2 tomes in 3 vols (Paris 1864-1867); I; p. 115.
[114] Wiesner: *Ueber die altesten bis jetzt aufgedundenen Hadernpapiere* (Vienna; 1911), in M. Lombard: *Les Textiles*; op cit; p.205.
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paper was manufactured both from cotton and linen;[116] and also from *shahdanj* (canamo).[117]

Lombard offers a succinct, but informative, outline on the manner Muslims manufactured paper.[118] This is also briefly outlined by Hunter, who explains that Muslims disintegrated linen rags, placing them in heaps, saturating them with water, and allowing fermentation to take place, then boiled the mass in wood ashes. The boiled rags were then placed in cloth bags and suspended in a running stream, the action of which removed a great part of the alkaline residue and much of the dirt.... Later, to beat the cleansed rags to a pulp a trip hammer was put to use. This improved method of maceration, Hunter notes, was owed to the Muslims.[119] Lombard also comments on this major point of difference between Muslims and Chinese; the Muslims manufacturing paper in mills.[120] Derry and Williams also note that the process was increased in efficiency by the addition of spikes to tear to pieces the rags which were the normal raw material.[121]

The use of natural power to activate machinery in paper making was a decisive breakthrough; by 950, water power was being used in fibre pounding in Baghdad.[122] Hill dwells on how hydraulic power activated machinery and the technical processes in use.[123] Specific natural conditions shaped particular usages of such power. Where the banks of the watercourse were high, as along the Euphrates, at Hama on the Orontes (Syria), at Amasia on the Yeshil Irmak (further east), or at Toledo in Spain, the current of the river itself was used to turn waterwheels, which produced energy for both paper mills, and for other mills (flour production, for instance).[124] The widespread use of such power is illustrated by the number of mills. In the city of Fes, in Morocco, for instance, 400 mills (operated by both water and wind power) were working

[116] In S.M. Imamuddin: *Muslim*; op cit; p. 111.
[117] Banqueri: Agricultura; ii; p. 118; in S.M. Imamuddin: *Muslim*; op cit; p. 111.
[118] M. Lombard: *Les Textiles;* op cit; pp. 205-6.
[119] D. Hunter: *Papermaking;* op cit; p.139:
[120] M. Lombard: *Les Textiles*; op cit; p.206.
[121] T.K Derry and T.I Williams: *A Short History of Technology* (Oxford at Clarendon Press, 1960), p.233.
[122] F. and J. Gies, *Cathedral, Forge, and Waterwheel* subtitled "Technology and Invention in the Middle Ages". Harper Perennial, 1995; p. 97. and Joel Mokyr, *The Lever of Riches* subtitled "Technological Creativity and Economic Progress" (Oxford, 1990), p. 41.
[123] See D.R. Hill: *Islamic Science and Engineering* (Edinburgh University Press, 1993), see chapter devoted to water wheels and mills .
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Finally, a word on the transfer to the Christian West. It was from Muslim Spain that paper making eventually first spread to Christian Spain. Tariff lists, citing tolls collected on Andalusi and Maghrebi paper in towns along the Ebro River in the late 12th century, demonstrate that paper was moving from Muslim to Christian parts in that period.[128] In the 13th century, the manufacture of paper was introduced by Alfonso X into Castile, whence it passed to France in 1270.[129] The first paper mill to be established in Bologna was in 1293, whilst in 1309 the first use of paper was recorded in England.[130]

Textiles:

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-R.J. Forbes: *Studies in Ancient Technology*; vol II, second revised edition (Leiden, Brill, 1965).
-D.R. Hill: *Islamic Science*; op cit;
-A F. Klemm: *History of Western Technology*; tr by D. Waley Singer (George Allen and Unwin Ltd, London, 1959).
-Al-Qazwini, *Works;* edit Wustenfeld (Cottingen, 1849), vol II.
-E. Wiedemann:*Beitrage zur Geschichte der Natur-wissenschaften. X. Zur Technik bei den Arabern* (Erlangen, 1906).
[128] R.I. Burns: The Paper Revolution in Europe: Crusader Valencia's Paper Industry; *Pacific Historical Review;* 50; 1981; pp. 1-30. at p. 24.
[129] Carreres: Historia de Jativa; I; 1933; p. 48; L. Viardot: Historia; p. 240; in S.M. Imamuddin: *Some Aspects of the Socio Economic and Cultural History of Muslim Spain* (Leiden; Brill; 1965), p.108.
[130] D. Hunter: *Papermaking;* op cit; p. 474.
[131] See for instance:
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-N. P. Britton, *A Study of Some Early Islamic Textiles in the Museum of Fine Arts*, Boston; 1938.

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excellent information on the numbers of looms, the craftsmen employed in the trade, and the burgeoning suburbs gravitating around textile manufacturing centres. Al-Idrisi counted as many as three thousand farms raising silk worms in the mountains around Jaen in the middle of the 12th century, and al-Shaqundi labelled this region 'Jaen of the silk' because so many people, both in the city and countryside, were involved in the silk trade.[132] In Morocco, the irrigated high plains of Dai and Tadla and the Um Rabi' Valley produced considerable quantities of cotton.[133] This made the country into an extremely important centre for cotton manufacturing, and a large share of the manufactured product was exported to the Sudan.[134] In Tinnis, in the Egyptian Delta, 5,000 looms were recorded;[135] in Fustat 900 could be found;[136] 4000 in Tripoli in Syria;[137] in Spain, in Almeria, 800 silk weaving looms were recorded,[138] and so on and so forth.

Syria was a particularly important industrial centre; cotton weaving workshops in particular, al-Muqaddasi referring to the cloth manufacturing workshops of Aleppo.[139] From Manbig and Aleppo, cotton of Wadi Butnan was conveyed to the manufacturing centres of eastern Mesopotamia, and to western Syria.[140] It seems, according to Lombard, that the Syrian workshops specialised in the production of cloth made of a mixture of silk and cotton; Syria, after all, was the largest producer of both items in the whole Mediterranean Basin.[141] A list of taxes on the city is given by the historian Ibn Shihna for the years 1212-3, which includes the following among the many other items of all kinds: the tax on dying factories: 80,000 dirhems; the tax on

-K. Erdmann: "Turkish Carpets," in *Seven Hundred Years of Oriental Carpets*, H. Erdmann, ed., May H. Beattie and Hildegard Herzog, tr. (1970), pp. 41-60.
-S. D. Goitein: *A Mediterranean Society*, in 5 vols; vol I, (Berkeley; 1967-1990).
-Carl J. Lamm: *Cotton in Medieval Textiles of the Near East*; (1937).
-M. Lombard: *Les Textiles*; op cit.
And the excellent work by R.B.Serjeant: *Islamic Textiles* (Librarie du Liban), 1972.

[132] Al-Idrisi: *Opus Geographicum;* v (Naples-Rome; 1975), p. 568.
Al-Shaqundi in Al-Maqqari: *Analectes sur l'histoire et la literature des Arabes d'Espagne* (Ed R. Dozy Leiden; 1855-60), ii. p. 146.

[133] E.F. Gauthier: Medinat ou dai; *Hesperis;* VI; 1926; p. 24.

[134] M. Lombard: *Les Textiles*; op cit; p.75.

[135] Nasir I-Khusraw; Tr Schefer; p. 110; n.1; in M. Lombard: *Les Textiles*; op cit; p. 222.

[136] Abd Allatif al-Baghdadi: *Relations d'Egypte;* by M. S. De Sacy (Imprimerie Generale; Paris; 1810-11), p. 409.

[137] E.G. Rey: *Les Colonies Franques de Syrie aux 12em et 13em siecles* (Paris; 1993), p. 215.

[138] Al-Idrisi: *Description de l'Afrique et de l'Espagne;* ed and Fr tr by R. Dozy and M.J. de Goeje (Leiden; 1866), p. 240.

[139] Al-Muqaddasi: *Ahsan*; Miquel Tr; op cit; p. 219; 205.

[140] M. Lombard: *Les Textiles*; op cit; p.69.

[141] Ibid.

silk: 80,000 dirhems.[142] The daily turn-over in the cloth trade in the bazaars of the city reached 20,000 Dinars.[143]

Besides quantity, quality was dominant, too. Al-Muqaddasi notes the excellent quality of the close-woven garments produced on the island of Sicily.[144] Scott insists on the strength and delicacy of texture of the textile products, and the extraordinary permanence of the dyes employed in the fabrics.[145]

There were dominant aspects of ownership and management. If every Muslim ruler had at his disposal a workshop for the manufacture of his preferred cloth, many workshops, privately owned, worked towards meeting the needs of the population and for export abroad.[146] It is not rare to see whole urban conglomerations involved in textile manufacturing, such as in the Egyptian Delta, where a considerable labour force worked under difficult conditions.[147] In Egypt, for instance, throughout the early Middle Ages, textile manufacture was partly a state owned industry, but there were also private capitalists employing wage workers for their own benefit, at very low wages, and under fairly strict supervision of the state.[148] The same was the case in the large urban working communities observed in Almeria by Ibn al-Wardi, and in Meknes, in Morocco.[149] In the Eastern half of Islam, large silk weaving establishments existed in Tyre, Antioch, Tripoli, and other cities, four thousand weavers being engaged in this craft in Tripoli alone.[150]

Growing alongside such communities were other functions, such as those of financiers, warehouse owners, transporters, etc;[151] Casanova noting how in

[142] Les *Perles choisies d'Ibn ach-Chihna;* tr by J. Sauvaget (Beirut; 1933), pp. 163.

[143] Gerspach: *L'Art de la Verrerie*; (A Quantin Imprimeur, Editeur; Paris; 1885), p.97.

[144] Al-Muqaddasi: *Descriptio imperii Moslemici*; ed. M.J. de Goeje; Bibliotheca Geographorum Arabicorum (Leyden; 1876; 2nd ed; 1906), III; p. 239.

[145] S.P. Scott: *History,* Vol II; p.589.

[146] M. Lombard: *Les Textiles*; op cit; p. 222;
M. Rodinson: *Islam and Capitalism*; op cit; p. 52.

[147] M. Lombard: *Les Textiles*; op cit; p. 223.

[148] M. Rodinson: *Islam and Capitalism*; op cit; p. 52.

[149] M. Lombard: *Les Textiles*; op cit; p. 223.

[150] M. Erbstosser: *The Crusades* (David and Charles; Newton Abbot; 1st pub in Leipzig; 1978); p.131.

[151] See Labib: *Handelsgeschichte Agyptens im Spatmittelalter* (Wiesbaden; 1965), pp. 182; 339.
A.M Watson: A Medieval Green Revolution: New Crops and Farming Techniques in The Early Islamic World, in *The Islamic Middle East 700-1900;* edited by A. Udovitch (Princeton; 1981), pp. 29-58; at p. 48.

Cairo, special quarters were reserved to cotton merchants,[152] whilst in Baghdad, there was a special wharf for cotton merchants and a special market for the trading of cotton.[153]

Islamic textile products found a large market stretching over the continents. Lombard, in particular, enlightens considerably on the primary position of Muslim textile products in exports.[154] The coloured garments produced in Basra, near Fes, in Morocco, possibly derived from both linen and cotton, were very much appreciated further south in the African continent, and merchants from the oasis of Sigilmasa traded such items in exchange for gold.[155] Andalusi fabrics made their way to the Christian world as early as the 9th century, as they then appeared in Latin sources, such as when Louis the Pious presented precious fabrics, including a Spanish coverlet to the Abbey of St Wandrille; ca. 823.[156] His son, Charles the Bald, received a variety of textiles as a gift from Cordova in 865,[157] whilst fourteen pieces of Spanish cloth, woven with rich silver thread were cited amongst the ecclesiastical donations of Pope Gregory IV (827-44), and a number of similar items were presented to different churches during the pontificate of Leo IV (847-55).[158] From the East, Syrian silk cloth was a popular export product, and was regarded as equalling the Chinese in quality.[159] Syria, in the Middle Ages, was, thus, the largest supplier of cotton of the whole Mediterranean world, and its product also renowned for its quality.[160]
Alongside trade, Islamic textile products introduced new linguistic expressions and new varieties of cloth and ideas into the Western realm; Damask, for instance, comes from Damascus; Fustian from Fustat and Muslin from Mosul, in which the respective types of textiles were believed to be manufactured.[161] Further words include cotton, divan, sofa, and mattress, as well as baldachin.[162]

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[152] P. Casanova: Essai de la Reconstitution de la ville d'Al Foustat ou Misr; *Memoire de l'Institut Francais d'Archaeology Orientale*; xxxv (1919).
[153] G. le Strange: *Baghdad Under the Abbasid Caliphate* (Oxford; 1924), pp. 84; 181; 265.
[154] M. Lombard: *The Golden*; op cit; pp 161 fwd.
[155] Al-Biruni: ed. F. Krenkow; *Revue de l'Academie Arabe de Damas*; XIII (1935), p. 341 and fol.
[156] O.R. Constable: *Trade and Traders*; op cit; p. 178.
[157] *Gesta sanctorum patnum Fontanellis cocnobii*; xiii. 4; eds F. Lohier and J. Laporte (Rouen-Paris; 1936), p. 102.
[158] *Liber Pontificalis;* n ed (L. Duschesne; Paris; 1955), pp. 75; 107; 122; 128.
[159] M Erbstosser: *The Crusades;* op cit; p. 131.
[160] M. Lombard: *Les Textiles;* op cit; p.69.
[161] C. Singer: East and West in retrospect in C.J. Singer et al: *History of Technology*; 5 vols; (Oxford at the Clarendon; 1956), vol 2; pp 753-777; p. 764.
[162] R. Ettinghausen: Muslim decorative arts and painting, their nature and impact on the medieval West; in *Islam and the Medieval West*; ed S. Ferber; A Loan Exhibition at the

The Islamic textile industry had a lasting effect on Western Christian manufacturing. This occurred via the usual Spanish and Sicilian routes. In Muslim Spain, during the reign of Abd Errahman II (r. 822-852), the textile industry of Cordova produced, under the direction of Harith Ibn Bazi, carpets, tapestries, clothes and robes of honour to be distributed among the nobles and courtiers at the time of the two 'Id festivals and at other celebrations.[163] Abd Errahman III (r. 912-61) also established extensive manufacture of silk and leather.[164] Documented evidence from 916 at the monastery of San Vincente of Ovideo shows a considerable number of Arabic expressions describing textile products and items of clothing.[165] Carpet manufacturing also played a major part in furthering Islamic crafts and skills, and in sharpening Western tastes. It was Eleanor of Castile who brought woven carpets to England in 1255 on her marriage to the future Edward I.[166] Gradually the once muddy and straw covered floors made way to carpets such as we have today.
In Sicily, the cultivation of cotton was introduced on the Island by the Muslims, either from Syria or from the Maghrib.[167] It reached the neighbouring island of Pantellaria, which, according to Abu'l Fida (b. 1273-d. 1331), exported considerable quantities of this textile product.[168] In 978, the traveller Ibn Hawqal wrote of a quarter in Palermo called al-Hara al-Djadida, or the New Quarter, in which there were various markets including a Suk al-Tiraziyin, or market for the makers of Tiraz stuffs, a quarter, which was presumably built soon after the capture of Palermo by the Muslims.[169] The textile factories of Palermo, which had fame under the Muslims, carried on under the Normans, of which remnants survive in the regalia of Roger II, preserved in the Treasury of the Holy Roman Empire in Vienna.[170] It is also from Islamic Sicily that the art of cloth dyeing spread to Europe.[171] The island was also a leading centre of the silk industry, and

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University Art Gallery; (State University of New York; April 6 - May 4, 1975), pp. 5-26; at p. 15.
[163] E. Levi Provencal: *Histoire*; op cit; I; p.257.
[164] J.W. Draper: *A History of the Intellectual Development of Europe*; Vol I; Revised edition (George Bell and Sons, London, 1875), Vol II; p.386.
[165] Aguade Nieto, S., *De la sociedad arcaica a la sociedad campesina en la Asturias medieval* (Universidad de Alcala de Henares, 1988), p. 156.
[166] John Sweetman: *The Oriental Obsession* (Cambridge University Press, 1987), p.5.
[167] M. Lombard: *Les Textiles;* op cit; p.78.
[168] See. A. Amari: *Bibliotheca arabo-sicula*; p. 228.
[169] Ibn Hawqal: *Opus Geographicum;* ed. J.H. Kramers; 2nd ed (Leyden; 1938-9), p. 119
[170] J. D. Breckenridge: The two Sicilies; in *Islam and the Medieval West*; S. Ferber Ed; op cit; pp. 39-59; p.54.
[171] G Le Bon: *La Civilisation des Arabes* (Syracuse; 1884), p.233.

even by the 12th century, under Norman rule, silk production seemingly still restricted to Sicily alone, before it spread from there to other regions in the course of the 13th century.[172]

Just like paper, the Islamic textile industry had a profound effect in stimulating other industries and the rise of technological expertise, both in the Islamic world, and subsequently in Western Christendom. The cotton industry, for instance, acted on the farming sector and stimulated the rise of dyestuffs, such as indigo, and other fibres, such as linen, which were often mixed with cotton.[173] Cotton also acted on the manufacture of clothing, and household articles made of cotton cloth or cotton wool.[174]
In respect to stimulating technological innovations, textile machinery was already in existence in Muslim Spain centuries before appearing in the rest of Western Christendom. Zozaya notes that the early phase lasting from 825 to 925 was marked by two interesting technological innovations, one of them being the horizontal loom, which appeared, together with the use, well in advance of Christian Europe, of silk thread,[175] as in the shroud of Ona, Burgos (datable to sometime around 925.)[176] The implications are clear: the horizontal loom was already in use in Al-Andalus at least three centuries before the rest of Europe, giving rise to a weaving industry there.[177]

The Glass Industry:

Glass was another early industry that thrived most particularly in Egypt and above all Syria. Abundant accounts from the whole medieval period testify to a thriving glass industry, which produced glasses of all shapes and colours, established in the cities of Alexandria, Cairo, Tyre, Aleppo, Antioch, Damascus, Tripoli, and elsewhere.[178] In both countries, lamp shades were made in glass adorned with medallions, inscriptions, or floral

[172] M. Erbstosser: *The Crusades*, op cit; p. 186.
[173] A. Watson: A Medieval Green Revolution; op cit; p. 47.
[174] See: A.M. Watson: The Rise and Spread of Old World Cotton; in *Studies in Textile History in Memory of Harold Burnham*; ed. V. Gervers (Toronto; 1977), pp. 355-68.
[175] J. Zozaya: Material Culture in Medieval Spain; in V.B. Mann; T.F. Glick; J. D. Dodds: *Convivencia; Jews, Muslims, and Christians in Medieval Spain* (G. Braziller and the Jewish Museum; New York; 1992), pp. 157-74; at p. 159.
[176] For the horizontal loom, see: M. Returece: El templen:, primer testimonio del telar horizontal en Europe?' *Bolletin de Arqueologia Medieval*; 1 (1987); pp. 71-7.
[177] J. Zozaya: Material Culture; op cit; p. 159.
[178] Gerspach: *L'Art de la Verrerie*; op cit. p.97.

designs. Syria was most particularly famed for the art of enamelled glass that would reach its peak of excellence in the 13th century.[179] Both Aleppo and Damascus were equally important centres, and so was Hama, where excavations yielded a wide range of material, mostly from the period between 1100 and 1400.[180] It is in Damascus' rich bazaars that Cairo traders found regular supplies of all luxury glass products.[181] Egypt itself continued to produce vessels of all qualities, particularly at Al-Fustat (old Cairo), where excavations yielded immense quantities of glass, ranging in date from the eighth century to the later Middle Ages.[182] The quality of Egyptian glass is such, that even in the more sophisticated parts of Christendom, that is the Eastern Roman Empire (Byzantium), the art was little regarded apart from its use in mosaics, and such Byzantine glass as has survived, owes much to the art of Islamic Egypt, if indeed, it is not in many cases actually of Egyptian origin.[183]

Advanced skills and techniques in glass production and decoration were common throughout the Islamic world. Besides wheel cutting, most of the techniques of surface manipulation were known in the Islamic world, including mould blowing and casting, stamped and pincered decoration and applied ornament.[184] Under the Tulunids, Abbasids, Fatimids, Ayyubids, and Mamluks, Muslim glass-makers created a new art of decorated glass hardly surpassed at any earlier or later time for strength, design and richness of colour.[185] The glass workers of the early Islamic period experimented in polychrome decoration of the surface; opaque coloured vessels were made in Egypt and incrustation with glass on another colour, the so-called technique of 'combed' decoration, was practised in Syria.[186] Some of the most sophisticated Egyptian glass vessels were decorated with lustre, a shiny, sometimes metallic effect, achieved by painting copper or silver oxide on the surface of the object, then firing it at a temperature of about 600°C (1112°F.) in reducing conditions.[187] In Spain, Ibn Firnas (d.887) introduced the art of glass manufacturing and taught artisans the technique of putting the clay in the

[179] W. Durant: *The Age of Faith* (Simon and Shuster, New York, 1950), Sixth printing; p.276.
[180] D. Whitehouse: Glass in *Dictionary of the Middle Ages*; op cit; vol 5; pp. 545-8.
[181] Simon Simeonis; p. 43 in W. Heyd: *Histoire*; op cit; vol 2; p. 710-1.
[182] D. Whitehouse: Glass; op cit; pp. 546-7.
[183] W.B. Honey: *Glass*; Victoria and Albert Museum (Ministry of Education; London; 1946), p. 35.
[184] D.B. Harden et al: *Masterpieces of Glass* (Allen Press; Oxford; 1968); pp. 100-1
[185] W.B. Honey: *Glass;* op cit; p. 35.
[186] D.B. Harden et al: *Masterpieces of Glass*; op cit; p. 101
[187] D. Whitehouse: Glass; op cit; p. 546-7.

oven.[188] Ibn Firnas, according to the 16th century historian al-Maqqari, established factories and was the first to make glass out of clay.[189] He advised the glass makers to keep the crystal in the oven for twenty four hours to make it strong.[190]

The Seljuks who dominated much of Islamic life in the 11th-12th century are generally seen as barbaric newcomers who caused the decline of Islamic civilisation.[191] Yet as this work will amply show, and as briefly highlighted here, this is far from being the case. Historians' hostility to the Seljuks (as to the Mamluks) has more to do with other considerations; i.e their role during the crusades, and stemming the crusader's onslaught on Islam. The Seljuks acted as patrons of many aspects of Islamic learning and crafts, and they gave a good impetus to artistic life in the countries where they exerted their influence.[192] Enamel painting on glass, just as the damascening of bronze, for instance, reached very high levels under the Seljuks before peaking under the Mamluks.[193] The typical lamp form also originated in Syria at the time of the Seljuks.[194] Djebbar notes how the glass industry led to advances in glasses (for vision) and optical sciences (telescopes).[195] Further links between glass making and other scientific applications are found in Selin's edition of a recent encyclopaedia under various entries.[196]

An important remark must be made here, that it is not Islamic civilisation that started glass making, or many of the techniques involved with the craft. However, just as with paper, Islamic civilisation innovated in many respects, on both the qualitative levels (aspects of which have been just seen), and

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[188] E. Levi Provencal: *L 'Espagne Musulmane*; op cit; p. 184.
[189] P. De Gayangos: *The History of the Mohammedan Dynasties in Spain* (extracted from *Nifh Al-Tib* by al-Maqqari); 2 vols (The Oriental Translation Fund; London, 1840-3), Vol I; pp. 148; 425.
[190] Al-Saqati; p. 67; in S.M. Imamuddin: *Muslim;* op cit; p. 118.
[191] See, for instance:
C. Brockelmann: *History of the Islamic Peoples* (Routledge; London; 1950); p. 240.
F.B. Artz: *The Mind of the Middle Ages*; 3rd ed revised (The University of Chicago Press, 1980), pp. 175-6.
K.N. Chaudhuri: *Trade and Civilisation in the Indian Ocean* (Cambridge University Press; Cambridge; 1985), p.36.
G. Wiet et al: *History*; op cit; pp. 243; 458; p.663.
[192] D.B. Harden et al: *Masterpieces of Glass*; op cit; p. 101
[193] G. Weiss: *The Book of Glass;* Tr J. Seligman (Barrie and Jenkins; London; 1971), p. 74.
[194] Ibid.
[195] A. Djebbar: *Une Histoire*; op cit; pp 347-9.
[196] H. Selin Editor: *Encyclopaedia of the History of Science, Technology, and Medicine in Non Western Cultures* (Kluwer Academic Publishers. Dordrecht/Boston/London, 1997).

quantitative level, i.e, the Muslim promoting the craft into an industry or pre-industry, involving numbers of workers, often working in association. Carboni, for instance, explains that the technology employed for molded glass was not that simple, and just as the finished products were sent to the engraver for cold cutting, a mould had to be conceived, prepared, and often cast in bronze before a glass vessel was created.[197] In both cases the glass maker sought another craftsman's skill in order to accomplish his task, thus making the chain of production more complex.[198] Before beginning his work, a glassmaker would have to obtain a mould from a mould-maker who was perhaps associated with the glass workshop itself or was an independent craftsman working for other craftsmen as well, a skilled metalworker, who would not have limited himself to making moulds for glass factories only.[199] Within this community of artisans, such as in the workshop quarters of Fustat or Nishapur, a glass maker could, thus, have commissioned the moulds from the neighbouring metalworker.[200] There is also, it must be insisted upon, a very strong link between the faith of Islam and the rapid expansion of the glass industry. As Weiss explains, the Muslims transformed their mosques, houses and cities into centres of rich decoration, but in this atmosphere, a special significance was accorded to glass (just as ceramics): it was required to replace the gold and silver vessels excluded on the grounds of faith,[201] for Islam rejected both luxury and the use of precious metals in decoration, most particularly in religious edifices.[202] Weiss contrasts this with the situation in the Christian West, where, in contrast to gold and silver and rock crystal with their precious, symbolic properties, glass was not noble enough for its use to be permitted as divine service.[203]

Exports in Muslim glass, especially Syrian, was a dominant trait of the medieval economy. The gilded and enamelled glasses for which the Near East was renowned were for the most part the product of Syria, and these products were exported as far as Egypt, Mesopotamia, China, Russia, Sweden and England.[204] Syrian glass had, indeed, a far reaching reputation feeding the tastes and the homes of wealthy Western

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[197] S. Carboni: *Glass From the Islamic Lands* (Thames and Hudson; 2001), p. 197.
[198] Ibid.
[199] Ibid.
[200] Ibid.
[201] G. Weiss: *The Book of Glass*; op cit; p. 65.
[202] R. Garaudy: *Comment l'Homme Devint Humain* (Editions J A; 1978), p.199-ff see I.R. and L. L al-Faruqi: *The Cultural Atlas of Islam* (Mc Millan Publishing Company New York, 1986), for a more extensive study of Islam and its impact on society, civilisation, culture etc.
[203] G. Weiss: *The Book of Glass*; op cit; p. 65.
[204] D.B. Harden et al: *Masterpieces of Glass*; op cit; p. 102.

households with glass products of a diversity of shapes and usages.[205] Syrian ports were very active centres of export, excavations in the port of Tripoli, for instance, yielding considerable amounts of fragments of glasses.[206] The large number of surviving objects in enamelled and gilded glass also bears witness to the extent to which they were appreciated from the time they were created. There is a special interest accorded to this type of glass in Europe, in the second half of the 19th century, in particular, witness the considerable literature on the subject of the period.[207]

The splendour and refinement of the medieval Islamic glass evidently aroused the great admiration in the more or less barbaric West.[208] The difference in quality between the extremely refined oriental glasses of the 13th century and the modest products of early Gothic hollow glass-making left only one direction in which the stimuli could pass.[209] In this sphere, Weiss maintains, the West had nothing to offer the East.[210] The existence of specimens preserved since the Middle Ages in European Cathedral treasuries, usually mounted in precious metals, is evident of the contrast then existing between the civilisation of Islam and the cultural darkness that covered most of Europe through this long period.[211] Going through the inventories of the time, Heyd points out, reveals bottles, goblets plates of glass, painted or decorated 'in the Damascus manner.'[212] Amongst the many instances is a famous beaker or cup with ornament that is preserved in the museum of Douai, in France. It was part of a bequest recorded in 1329 that included an endowment for poor clergy, and was probably brought from Palestine by a crusader in 1251.[213]

A final word on the industry, to touch on an issue that will be amply looked at in the final part of this work (on the decline of Islamic civilisation), and which relates to the decline of the glass industry. Carboni, for instance, refers to enamelled glass, its high place in Syrian manufacturing and exports to the Christian West, as well as the vast Western literature on the subject in the 19th century, and raises queries

[205] Instances in Labarte: Inventaire du mobilier de Charles V; p. 240 and sub in W. Heyd: Histoire; op cit; vol 2; p. 710.
[206] Gerspach: *L'Art de la Verrerie*; op cit; p.97.
[207] S. Carboni: *Glass from Islamic Lands;* op cit; p. 323.
[208] W.B. Honey: *Glass;* op cit; p. 35.
[209] G. Weiss: *The Book of Glass;* op cit; p. 66.
[210] Ibid.
[211] W.B. Honey: *Glass;* op cit; p. 35.
[212] Labarte; in W. Heyd: *Histoire*; op cit; vol2 ; p. 710.
[213] W.B. Honey: *Glass*; op cit; p. 46.

about its disappearance in the 15th century.[214] This disappearance coincides with the rest of Syrian manufacturing in all its forms, which came as a result of the invasion and devastation of Syria by Timur the Lame, which occurred precisely in the last years of the 14th and early years of the 15th century. In his assault and devastation of Syria, where he made pyramids of skulls, Timur only spared one group: artisans, whom he carried back to his capital in Samarkand.[215] Syrian trades and industries, by far the most advanced of the medieval era, totally disappeared following his onslaught.[216] This meant, Weiss insists, that the great days of Syria and Egypt were gone for good.[217] Included amongst the losses was the once thriving glass industry.[218] From being once the exporter of skills and glass products, the situation was reversed in the 15th century; now Venetian workshops executed orders for enamelled glass mosque lamps for the Near East.[219]

The Sugar Industry:

In many Islamic parts flourished a strong sugar industry, where again, as with previous industries, modern processes of industrial production were in operation, i.e.: the use of natural power to activate machinery, production for a mass market; etc. The sugar refineries were run by the state, but also with the involvement and partnership of private manufacturers.[220] Heyd provides a great many details on the industry, most particularly in the outline at the end of his work.[221] He explains how sugar cane was initially cultivated in India, Indo-China and also China proper; but neither did the Chinese, nor the Indians, invent the manufacturing processes; for centuries all they did was to crush the cane

[214] S. Carboni: *Glass From the Islamic Lands;* op cit; p. 323.
[215] E. Gibbon: *The Decline and Fall of the Roman Empire*; op cit; vol VII; 1920; pp. 55-6.
D. Whitehouse: Glass; op cit; p. 547.
Sir Edwin Pears: The Ottoman Turks to the fall of Constantinople. In *The Cambridge Medieval History*, (Cambridge University Press, 1923), Vol IV: Edited by J. R. Tanner, C. W. Previte; Z.N. Brooke, 1923, pp 653-705; pp.679-80
[216] G. Sarton: *The Incubation of Western Culture in the Middle East*, A George C. Keiser Foundation Lecture, March 29, 1950 (Washington DC; 1951), Note 35; p.35.
D. Whitehouse: Glass; op cit; p. 547.
[217] G. Weiss: *The Book of Glass;* op cit; p. 67.
[218] D. Whitehouse: Glass; op cit; p. 547.
[219] D.B. Harden et al: *Masterpieces of Glass*; op cit; p. 103
[220] M. Rodinson: *Islam and Capitalism;* op cit; pp. 52-3.
[221] W. Heyd: *Histoire du Commerce;* vol 2; op cit; pp. 680-92.

and extract the juices, which they then thickened on fire. The method of refining sugar via chemical processes was carried out in Islamic lands; the Muslims developing the art of refining sugar within the Caliphate, and taking it beyond the frontiers.[222]

The introduction of sugar cane into Syria followed hard on the Arab entry into the country in 634, the first mention of the sugar cane in this country is found in Jacob of Edessa (640-70).[223] A thriving industry developed, and was located along the coastal area of the extreme east of the Mediterranean, in the centres of cultivation at Laodicea, Tripoli, Sidon, Tyre, Caesarea, Palestina and Acre, whilst inland, the cane was established around Antioch, Aleppo, Damascus, etc.[224] This thriving industry is described by Muslim geographers such as al-Istakhri (fl. 950).[225] In Damascus, just as in Cairo, whole streets were set aside for sugar refineries.[226] In Egypt itself, Al-Bakri (b.ca 1010-d. 1094) mentions sugar mills on the left bank of the River Nile, at Terennout, forty miles north west of Cairo.[227] Here, the sugar industry stimulated the growth of the plantation of sugar cane, and from the close of the 8th century, the most fertile land was planted with sugar cane.[228] All medieval Muslim travellers spoke of the richness of the industry in the country, according to their accounts, there must have been a continuous strip of cane cultivation and sugar mills.[229]

The industry was also introduced by the Muslims when they entered North Africa (Tunis in 648; Morocco in 682). Abu Hanifa al-Dinawari (d. 895) says that the sugar of Zingis (Tangiers) was the best known to him, a similar statement found in Al-Bakri (b. ca 1010; d. 1094), and al-Idrisi (b. 1099-1100-d. 1166), who wrote:

> 'When one leaves Egypt, where still some sugar mills are found at Teremut, much carob bean (which affords good syrup) is seen at Mina, and on reaching the fertile lands of the north coast there are great quantities of sugar cane, which gives an enormous yield in Tripoli and Tunis, and among other places at Al-Kayrawan, where there is also manna and jasmine honey of proverbial goodness.

[222] Ibid; pp. 680-1.
[223] C. Brockelmann: *Geschchite der Christlichen Literaturen des Orients* (Leipzig; 1907), p. 47.
[224] N. Deerr: *The History of Sugar* (Chapman and Hall Ltd; London; 1949), vol 1; p. 74.
[225] C. Brockelmann: *Geschchite*; op cit; p. 47.
[226] A.M. Watson: A Medieval Green Revolution; op cit; note 49; p. 58.
[227] Al-Bakri: Descriptions de l'Afrique Septentrionale; in *Journal Asiatique*; 5th series; XII; p. 415.
[228] M. Lombard: *The Golden*; op cit; p. 167.
[229] N. Deerr: *The History of Sugar*; op cit; pp. 87-8.

> The greatest abundance is, however, in the Maghrib where, near Igli, so much is planted that a man's load costs only a quarter of a dirhem, and 1 qantar (100 kgs) of sugar costs only 2 mithghals, and the sugar produced here supplies the whole of the Maghrib.'[230]

In Sicily, where the industry was introduced soon after the Muslim arrival (827 ff.), the Muslim geographer, Ibn Hawqal, writing in 950, says:

> 'The banks of the streams around Palermo, from their sources to their mouths, are bordered by low lying lands, upon which the Persian reed is grown. The juice is obtained by pressing mills.'[231]

Accounts also speak of major sugar production in 10th century Spain; the chief centres being Elvira, Malaga and Seville, especially along the Mediterranean coast.[232]

The making of sugar is described by contemporary Muslim writers, such as Ibn al-Awwam (fl. end of 12th century):

> 'On the manner of making sugar from these (sugar canes), says Abu el-Jair, that when the cane have reached the end of their proper season in the above mentioned time of the month of January, they are cut in small pieces and these are well trodden on or broken in a wine press, or similar presses; that its juice is placed in a clean boiler on a fire to cook and left till it becomes clear, after that it is made to boil again, until it becomes one fourth of its first volume. It is then put into receptacles, forms, or vases made of clay of a peculiar shape, or conical.[233] It is placed in the shade to harden, and the sugar from it is placed in the shade to aerate, and the residue of the cane after the extraction of the juices is kept for the horses because it is pleasing to them and very fattening.'[234]

There is a much more detailed and richer description of the same process by the Egyptian al-Nuwairi (d.1331-2):

> 'The cane is carried on the backs of camels and asses, and unloaded at the 'House of the sugar cane.'... Men sit astride on seats and hold in their hands knives which are larger than those used to cut the cane. In front of them are tables. A man takes a

[230] Al-Idrisi: *Geographie*; tr. Jaubert, (Paris; 1836), I; p. 208.
[231] Schack: *Geschichte der Normannen in Sicilia* (Stuttgart; 1889), I; p. 292.
[232] E. Levi Provencal: *l'Espagne*; op cit; p. 167.
[233] N. Deerr notes that this is the earliest statement which makes definite reference to the sugar cone of sugar loaf; in N. Deerr: *The History;* op cit; note p. 81.
[234] Ibn al-Awwam: *Libro de agricultura*, ed. J. A. Banqueri, (Madrid, 1802), in N. Deer: *The History*; op cit; p. 80-1.

number of stalks and cuts them into small pieces, which he throws into the 'House of pouring.' There, they are placed in baskets, which are called *ijara*, and are all of the same size. They are then carried to the mill stone. The cane is laid under the stone which is turned over the lower stone. The juice is pressed out and flows by openings in the base to the holder, the outlet of which is stopped. The cane is then taken to another place. Here it is placed in baskets of plaited work of *halfs* (rushes), which are slit open below and at the sides. These are laid under the wheel of a beam, and by means of the beam the wheel rolls on them until it has crushed them, and the rest of the juice has been pressed out. The juice that is pressed out by the stone mill and the beam *(tacht)* is brought to the same place. The juice is passed through a sieve, which is placed in a kind of frame. From this it flows to a closed vessel, which is called a *bastula*, in predetermined quantity. When this is filled with strained juice it is brought to the place where it is boiled. It is then strained a second time and led to a large boiler *(chabia)*. Into this is poured with straining all that is in the *bastula*. This holds 50 *matr* of juice. Each *matr* is half an official Latin *qintar*. The Latin *qintar* has 200 dirhem. Therefore the *chabia* holds 3,000 *ratl (ratl* = approximately 1lb). This is the content of the *bastula*.'[235]

The sugar industry rose into a dominant industry in medieval Islam. It involved a considerable labour force, and tied up large investments in plant and machinery.[236] Evidence of mass production of sugar was obvious during times of festivities in 10th century Egypt, when trees were decorated with tiny sugar figures, also evidence, according to Lombard, of progress in its manufacture.[237] Ibn Battuta (1304-1368-9) who in 1336 travelled up the Nile for 600 miles, recounts that in Cairo, at the serails, every Friday travellers were served with sweetmeats, and at Maulaway, where there were eleven sugar factories, the poor people came into the boiling house without interference to soak their bread in the hot syrup.[238] The finished products, in turn gave rise to many industries such as the

[235] In E. Wiedemann: *Beitrage zur Geschichte der Naturwissenschaften*; xli; 1915; p. 89.
[236] On the heavy investment in sugar refineries, see P. Berthier: *Les Anciennes sucreries du Maroc et leurs reseaux hydrauliques* (Rabat; 1966), I; pp. 129 ff; M. Benvenisti: *The Crusaders in the Holy Land (*Jerusalem; 1970), pp. 253-6.
[237] M. Lombard: *The Golden,* op cit; p. 167.
[238] Ibn Battuta: *Voyages d'Ibn Battuta*, Arabic text accompanied by French translation by C. Defremery and B.R. Sanguinetti, preface and notes by Vincent Monteil, I-IV (Paris, 1968), reprint of the 1854 ed; Vol 1; p 60. see also pp. 74; and 101.

making of sweets, pastries, and confectioneries.[239] Confectioners supplied a thriving trade in sweets of all sorts, made from sugar or honey, and almond and fruit pastes; the stalls were abundant in the markets alongside those of syrup and confection makers.[240] Desserts, Lombard reminds us, are after all of Oriental origin.[241]

As it rose in importance, the manufacture and trade of the commodity eventually became the monopoly of the state. Early in the 11th century, the Fatimid ruler, Ali Mansur (r. 966-1020) declared a sugar monopoly, and attempted to raise the price by the destruction of stocks.[242] Mamluk sultans and emirs (Mid 13th century onwards) acted as factory owners and wholesale suppliers of the commodity.[243] Sugar works were apparently attached to sugar cane fields, and so must have belonged to landowners, but such landowners (Mamluks) were in partnership with manufacturers in the province of Girgeh, supplying land and animals, undertaking the construction and upkeep of buildings, and sharing the profits with the man who was responsible for running the factory.[244] In Egypt, as elsewhere, sugar made its contribution to the revenue. The taxes were imposed not only on water rights, which sugar shared with other crops, but on cane, on mills, on their equipment generally, on the number of employees, on the factories as a whole and on their owners.[245]

Whatever may have been the local consumption, there was a great surplus for trade. The Egyptian sea trade was mainly with Venice, and also Genoa, and the land trade was mainly to Syria and Persia, trade that had its dangers, as there are records of caravans seized, such as one by Richard Coeur de Lion.[246] Another 600 camel loads of sugar were seized in 1280 by the Mongols.[247] Of trade from Morocco, there is mention in English sources, the Durham account rolls (about 1299) refer to Zucker Marrokis, and again in 1310 is found the entry '31 li. De Coukar de Marrok.'[248]

[239] A.M. Watson: A Medieval Green Revolution; op cit; p. 47.
[240] G. Wiet et al: *History*; op cit; p. 332.
[241] M. Lombard: *The Golden Age*; op cit; p. 167.
[242] Von Lippmann: *Zeitschrift des Vereins der deutsche Zuckerindustrie*; xlvi; 1921; p. 7.
[243] I.M. Lapidus: *Muslim Cities in the later Middle Ages* (Harvard University Press; Mass; 1967), at p.127.
[244] M. Rodinson: *Islam and Capitalism*; op cit; p. 53.
[245] N. Deerr: *The History of Sugar*; op cit; p. 93.
[246] Gale: *Historia Anglicana Scriptores quinque* (Oxford; 1887-97), ii; p. 407.
[247] Al-Makrisi: *Histoire des Sultans Mamloukes* (Paris; 1840-46), I; p. 38.
[248] Quoted in New Oxford Dictionary under Sugar.

Skills in the manufacturing of sugar seem to have remained uniquely Muslim for centuries. When they arrived in the East, (12th century onwards) the crusaders found that the Syrians were not just expert at growing sugar, but that they had also mastered the technique of crushing it under presses, extracting the juices, concentrating the substance on fire, then drying it out slowly into sugar.[249] The Crusaders took over the industry, and followed precisely the Muslims system of production, using the same Muslim terminology.[250] At Acre, they used Muslim prisoners in the manufacture of sugar.[251] Equally, the Sicilian ruler, Frederick II (d. 1250), asked for workers to be sent from Tyre, in Syria, to Palermo as the local Sicilians had lost the skills; the request was made to the Marshall Ricardo Filangieri.[252] In Spain, after it was taken by the Christians (13th century), a proportion of Muslim personnel was retained even after the Muslim final expulsion from the country in the early 17th century (1609-1610).[253]

Other Products and their Exports:

Other industrial products will be the object of attention in the chapters on sciences, but it is worth mentioning here how advances in chemistry, for instance, stimulated industrial outlets such as cosmetics, soaps, tinctures and their applications in tanning and textiles, distillation of plants, of flowers, the making of perfumes; therapeutic pharmacy, etc.[254] Multhauf gives a good account on such developments, including the production of heavy chemicals and synthetic substances.[255] Singer also studies the early association of chemistry and industry.[256] A Mediterranean based industry of the Middle Ages was the production of alkali.[257] Natron was an impure soda (sodium carbonate), but the ashes of sea or shore vegetation yielded a purer form of

[249] Jacques de Vitry in W. Heyd: *Histoire*; vol 2; op cit; pp. 685-6.
[250] W. Heyd: *Histoire*; op cit; vol 2; pp. 685-6.
[251] Michaud-Reinaud: Bibliotheque des croisades; IV; p. 126; in W. Heyd: Histoire; op cit; pp. 685-6.
[252] *Historia Diplomatica Friderici secundi*; ed (J.L. A. Breholles; Paris; 1852-61), Vol 5; pp.574-5.
[253] S.M. Imamuddin: Muslim; op cit; p. 92.
[254] J. Mathe: *The Civilisation of Islam*, tr. by David Macrae (Crescent Books, New York); A. Djebbar: Une histoire; op cit; p 334.
[255] R.P. Multhauf: *The Origins of Chemistry* (Gordon and Breach Science Publishers; London, 1993) pp 160-3.
[256] C. Singer: *The Earliest Chemical Industry* (The Folio Society; London; 1958).
[257] R.P. Multhauf: *The Origins of Chemistry*; op cit; p.345.

soda, called by the Arabs kali (hence alkali), and those of inland plants yielded potash (potassium carbonate), both of which were produced in various places.[258] Another early industry was that of oil, the word naphtha, it must be noted, derived from the Arabic *naft*. Under state monopoly, it served many purposes, domestic and non domestic: lighting, energy, sealing vessels and constructions, as a cure for particular diseases, etc.[259]

The fishing industry drew Muslim fishermen extremely far from their shores. The fishing industry of Spain receives a great deal of attention from Levi Provencal who tells that it prospered in the 10th century, in particular.[260] A wide variety of means and techniques were used in fishing.[261] Tuna catches were particularly important,[262] and the Muslim geographer-traveller, Al-Bakri, offers very interesting accounts of tuna fishing in the coastal regions of the province of Sidona during the passage of the fish between the Atlantic and the Mediterranean in the month of May.[263]

The diversity of Muslim manufactured products is highlighted by their place in exports to Western Christendom.[264] Northern literature and documents are full of references to Muslim textiles, leather, paper, and other imports.[265] Muslim leather objects, for instance, were highly prized, Cordova' products famed as far as Wales, and leather's wide use in the manufacture of shoes is linguistically demonstrated in the French word 'cordonnier' (shoe maker) and the English equivalent, cordwainer.[266] Artz lists an array of products, which Europe, Asia and Africa imported in great abundance from the Islamic world. These included carved ivories, enamelled glassware, tooled leatherwork of all sorts, tiles, pottery, paper, carpets, illuminated manuscripts, metalwork including damascened

[258] Ibid.
[259] A. Djebbar: *Une Histoire*; op cit.
[260] E. Levi Provencal: *Histoire de l'Espagne;* op cit; (see chapter on economic activities).
[261] C.E. Dubler: *Uber das Wirtschaftsleben;* op cit; pp. 35-39.
[262] E. Levi Provencal: *Histoire de l'Espagne*; vol 3; op cit; p.297.
[263] Al-Bakri in E. Levi Provencal: *Histoire,* op cit; p.298.
[264] See for instance:
-W. Heyd: *Histoire du commerce; o*p cit.
-M.A. *Cook: Studies on the Economic History of the Middle East* (Oxford; 1970).
-C. Cahen: Commercial relations between the near east and Western Europe from the VIIth to the XIth Century; in: *Islam and the Medieval West*: K.I. Semaan; ed (State University of New York, Albany; 1980), pp 1-25.
- S. D. Goitein: *A Mediterranean Society*, op cit; I; 1967.
[265] O.R. Constable: *Trade and Traders;* op cit; p. 47.
[266] Ibid; p. 144.

swords and vessels, fine cotton cloth, and rich silk fabrics. Today the Islamic sections of our museums, Artz holds, still 'cherish these matchless objects of expert and exquisite craftsmanship.'[267] Durant also insists that Europe imported all its wares and textiles from the Muslim world, or from China, via the Muslim world, the soaps, like the swords of Syria, in particular, being then of great renown.[268] Amongst other Syrian exports, from Aleppo, for instance, were cotton, spices, salt, cereals, pottery, glass, and soap.[269] Metal utensils were also vastly traded, Wiet et al noting the Muslim superiority over their neighbours in this and other industrial crafts.[270]

Rather than dwelling too long on such exports, especially their quantitative side, it is more informative to examine the manner Islamic trade was organised, its foundations, and the way finance was organised around it.

3. Islamic Fundamentals of Trade and Finance:

It is overwhelmingly assumed that our modern banking and commercial techniques owe much to the skills and inventiveness of the medieval Italian republics: Venice, above all, but also Genoa, Pisa, Florence, and Amalfi. The Western (Italian) origins of such inventiveness and techniques is summed up by one of the leading Western 'scholars', Chaunu, who tells us:

> 'The Bill of exchange was in use between Athens and Pontus, according to the irrefutable evidence in Isocrates' Trapeziticus, but it was lost and forgotten.... Therefore the effective development of commerce really began around 1000, on the eve of three centuries of demographic expansion, which was to encourage intelligence, wealth and durability. The main trade route was between the western end of the Mediterranean and the eastern end, where the Byzantine Empire was populous and

[267] F.B. Artz: *The Mind of the Middle Ages*; 3rd ed (The University of Chicago Press, 1980), p. 175.
[268] W. Durant: *The Age of Faith*, op cit; p.276.
[269] A.M. Edde: Alep; in *Grandes Villes Mediterraneenes du Monde Musulman Medieval;* J.C. Garcin editor (Ecole Francaise de Rome; 2000), pp 157-75; at p. 171.
[270] G. Wiet et al: *History;* op cit; p. 320.

> therefore wealthy, and the first to resume the techniques and thinking of antiquity.
> Eleventh century Italy established the most rudimentary tools of commercial capitalism. Apart from the age-old systems of a loan against security and an exchange of money, we find evidence of the existence of a commercial company in Venice in a text dated 976, and numerous company contracts have been preserved dating from the eleventh century on. For large scale commercial ventures there was the maritime or high risk loan which put the risk onto the money lender. The first colleganza contract appeared in Venice in 1072-3, and in Genoa in the twelfth century, under the Latin name of societas maris, or maritime company. These developments were responsible for the enormous change in commercial methods in the twelfth and early thirteenth centuries. They made possible logistic support for the crusades, which were a sign of the health of Latin Christendom and of her aspirations.
> Early rules of partnership were set up, particularly that of salva eunte navi, which put the risk onto the capitalist money lender. The salva eunte navi regulated the un-formalised kind of insurance which is implicit in partnership and the dividing up of risks.'[271]

And:

> 'During the thirteenth century in Italy and Catalonia, cautious instruments of credit were gradually established around the oldest deposit and credit banks. The most important of such instruments was payment 'in writing,' which means by transfers.'[272]

And:

> 'The bill of exchange was the best instrument of credit. It was developed outside the deposit bank by an elite group, the great merchant bankers or merchant exchange brokers who had secure international connections across the fairs of Europe.'[273]

Of course Chaunu makes assertions without giving us one single piece of evidence. He certainly counts on his immense reputation of 'great scholar' to do away with such frivolities. The general editor of the English version of Chaunu's work does, indeed, remind us on the very first page of 'Professeur Chaunu's great academic accomplishments.'[274] This is a

[271] P. Chaunu: *European Expansion in the Later Middle Ages;* Tr by K. Bertram (North Holland Publishing Company; Amsterdam; 1979), p. 260-1.
[272] Ibid; p. 266.
[273] Ibid; p. 267.
[274] Ibid; General Editor's note.

ridiculous assertion, which fails to convince this author. Indeed, first and foremost to assert that the crusades were a sign of the health of Latin Christendom and her aspirations, as Chaunu does, is an outrageous assertion, for how can the mass slaughter and rape of Muslims, eating their flesh, and burning of Jews in their homes and synagogues which resulted from this episode be a sign of health? One assumes this is a sign of barbaric depravity, instead. With regard to the matter under discussion here, on the development of commercial methods and new banking techniques, the first criticism of Chaunu's assertion just as with similar ones is that there is no such a thing as techniques or learning disappearing for centuries suddenly to re-appear, fresh, just as centuries before, as he tells us with regard to the Bill of exchange. This is an idiotic concept of aspects of civilisation disappearing, and then centuries later being recovered, which, unfortunately is not unique to Chaunu, but is shared by most Western 'historians,' who each in his or her field, use it to justify the sudden appearances of signs of civilisation and sciences in the 12th century, most particularly, and in order not to attribute their origins to the Muslims, tell us, instead, that such aspects of civilisation and sciences, hundreds of them, belong to Greece and Rome, that they disappeared for over ten centuries, and then were recovered by the genius of the West. This work will show countless instances of this approach, whereby such 'historians' suppress the Islamic role in the rise of many aspects of civilisation and sciences, and then resort to this explanation of sudden recovery of lost Western heritage for their sudden appearance on Western Christian soil.

With regard to the specific matter of the Bill of Exchange, debated here, had Chaunu and 'historians' of similar ilk just consulted the material evidence available, including letters of Jewish traders of Cairo from the times of the first Crusade (1090s), they would have found that all methods and instruments of credit, and all forms of trade associations were known already to the Muslims centuries before the Christian West, and were not invented in Europe as asserted by many.[275] Another criticism of Chaunu is when he tells us that commerce developed 'in the year 1000, and that the main commercial route was between both ends of the Mediterranean;' this statement being yet one more proof of how wild assertions are made without any effort to check their veracity. Had Chaunu given the slightest attention to facts, as will be amply shown further on, he would have discovered that commerce did not develop in the year 1000, but many centuries earlier, and that commercial routes between both ends of the Mediterranean also date from centuries earlier, stimulated by Muslim

[275] F. Braudel: *Grammaire des Civilisations* (Flammarion, 1987), p.96.

shipping and commerce above all. What is terrible in regard to Chaunu's statement is that it is one thing to make errors with regard to complex matters, but to state something that can easily be proved wrong, as Chaunu does with regard to maritime commerce awakening in the year 1000, is unworthy of print.

What Chaunu and the hordes of 'historians' of similar ilk fail to tell us is that the foundations of modern trade were laid in the Islamic world over the period under examination here (7th-13th centuries), and that such techniques found their way to the Italian cities, because it is precisely these very Italian cities which traded with Muslims. Had Chaunu and the hordes of similarly minded historians been right in attributing such techniques to the Christian West, it would have made sense if such techniques had appeared in Greece, or other parts of the Christian West, or even Byzantium, which was the heir to Greece and Rome. Instead, such techniques appeared, and precisely amongst the Italian cities trading with Muslims, and centuries after similar techniques had already appeared in the Islamic world.

In the following discussion, it is the latter point, the pioneering role of Islam in establishing the fundamentals of trade and modern finance, centuries before the Italians, which is first highlighted. The following will also demonstrate that these developments are fundamentally Islamic, for they have their source in the Islamic faith. Then, albeit briefly, some forms and ways of impact upon the Christian West, are looked at.

a. The Islamic Pioneering Role:

Relying on a diversity of sources Cahen outlines some of the intricate links that exist between Islam and trade:

> 'Let us first rid ourselves of an idea that Pirenne himself seem to have had, namely, that Arabs and Islam are marked by a kind of native impotence in economics and trade.[276] No matter what modern developments have been, the Arabs, as far back as pre-Islamic times, organised trade caravans which were at least inter-regional,

[276] Since it would be impossible to list here a bibliography of this immense subject, Cahen points out, he judiciously recommends M. Rodinson: *Islam and Capitalism* (Paris, 1966).

reaching as far as Syria.[277] Through the Yemen, they were in contact with the Indian Ocean's traffic. Islam was born in a mercantile milieu. Muhammad was a merchant and was not troubled by it. Several of his companions were merchants, and if evidently certain practices of the surrounding states were unknown to them, the reverse was perhaps also true.[278] In any case there was no question of a basic Muslim incapacity to trade.'[279]

Trading first and foremost finds a good place in the Islamic religious text and the sayings of the Prophet (or Tradition). The Qur'an looks with favour upon commercial activity, confining itself to condemning fraudulent practices and requiring abstention from trade only during certain religious festivals.[280] The Qur'an does not merely say that one must not forget one's portion of this world (28:77), it also says that it is proper to combine the practice of religion and material life, carrying on trade even during pilgrimages, and goes as far as to mention commercial profit under the name of 'God's bounty' (2:193-4/197-8; 62:9-10).[281]

Equally, the Prophet, himself a trader, just like most of his companions, said:

> 'The merchant who is sincere and trustworthy will (at the Judgment Day) be amongst the prophets, the just and the martyrs; or 'the trustworthy merchant will sit in the shade of God's throne on the Day of Judgment,' or 'Merchants are the messengers of this world and God's faithful trustees on Earth.'[282]

The earliest known Muslim work on economic ethics consists very largely of a collection of sayings attributed to the Prophet and the early heroes of Islam entitled *Kitab al-Kasb* 'On Earning,' written by a Syrian called al-Shaybani, who died in 804.[283] Shaybani's purpose is to show that earning a livelihood is not merely permitted, but is incumbent on Muslims. Man's primary duty is to serve God, but to do this properly, he must be adequately fed, housed and clothed. This can only be achieved by working

[277] See A. Udovitch: At the origins of the Western Commenda, in *Speculum* 37 (1962); pp. 198-207.
[278] Synthese in A. R. Lewis: *Naval Power and Trade in the Mediterranean, 500-1100* (Princeton University Press; 1951).
[279] C. Cahen: Commercial relations; op cit; at p.3.
[280] See W. Heffening: Tidjara; in *Encyclopaedia of Islam;* 1st ed; vil 4 (Leiden; 1934), p. 747. See. M. Rodinson: Islam and Capitalism; op cit; p. 14.
[281] M. Hamidullah in *Cahiers de l'ISEA*; Supplement No 120; Series V; No 3; December 1961; pp. 26 and fl:
[282] See Wensick: A Handbook of Early Muhammadan Tradition (Leiden; Brill; 1927), in M. Rodinson: *Islam and Capitalism*; op cit; p. 16.
[283] The original work is lost, but it survives in fragments in the author's pupil: Ibn Sama'a (d. 847) entitled *Al-Iktisab fi'l rizk al-mustatab* (Cairo, 1938).

and earning.[284] Another point made by al-Shaybani is that money earned by commerce and industry is more pleasing to God's eyes than money received from the government for civil or military service.[285] The same point is argued by al-Jahiz (d.869) in an essay entitled 'In praise of merchants and in condemnation of officials,'[286] Al-Jahiz insisting on the security, dignity and independence of merchants in contrast with the uncertainty, humiliation and sycophancy of those who serve the ruler; Al-Jahiz defending the piety and the learning of merchants against their detractors.[287]

Faith and practice in Islam being closely related, and trade even being seen as an agent to spreading the faith, it is little surprise that trading activities flourished wherever Muslims established themselves, and wherever they could reach. Garaudy points out how agrarian communities based on the Savannah or forest evolved in the 8th century into great empires, a consequence of large scale trade in the geographical area where Islam was present, from Cadiz to China.[288] Muslim commerce dominated the Mediterranean till the Crusades, plying between Syria and Egypt at one end, Tunis, Sicily, Morocco, and Spain at the other, and touching Greece, Italy, and Gaul.[289] It captured control of the Red Sea from Ethiopia, reached over the Caspian into Mongolia, and up the Volga from Astrakhan to Novgorod, Finland, Scandinavia, and Germany, where it left thousands of Muslim coins.[290] Muslim shipping was also prominent throughout the Indian Ocean, and as early as 750, merchants from the Gulf made the long voyage to China.[291]

The Muslim merchants' reach was remarkable when one considers the shipping and navigational conditions of the time.[292] The Spanish Muslim, Abu Bakr Al-Marwani (d. 968), for instance, reached the markets of Iraq and India where he amassed 30,000 dinars through trade before losing

[284] In B. Lewis: Sources for the Economic History of the Middle East in *Studies in the Economic History of the Middle East*; Edited by M.A. Cook (Oxford University Press; 1970), pp. 78-92; p.87.
[285] Ibid.
[286] See partial translation by O. Rescher: *Excerpte und Ubersetzungen aus den Schriften... Gahiz*, (Stuttgart; 1931), pp. 186-8.
[287] B. Lewis: Sources; op cit; pp. 87-8.
[288] R. Garaudy: *Comment l'Homme devint Humain* (Editions J.A, 1978), p.271.
[289] W. Durant: *The Age of Faith*, op cit; p. 208.
[290] Ibid, p. 208.
[291] A. Pacey: *Technology in World Civilization, a Thousand year History* (The MIT Press, Cambridge, 1990), p.12.
[292] Wang Gungwu: *Transforming the Trading World of Southeast Asia*[i] at http://hometown.aol.com/wignesh/5Wanggungwu.htm.

everything in a shipwreck on the way home to al-Andalus.[293] After 1100, Indian cotton goods and Chinese porcelain were reaching very remote Indonesian islands (whose main exports were spices) and distant African ports (whence came ivory and gold.)[294] Then, only the Muslim Arabs and Muslim South Asians who led the trade with China had such a background and their efforts enabled them to extend their enterprises into the Malay Archipelago.[295] Eventually, the Muslims stimulated Chinese merchants themselves to develop better ocean-going shipping to trade in the region as well.[296] Such achievements testify to the way commercial vigour could fashion and enhance civilisation when trade flourished freely and attracted the active participation of local elites.[297] Which, Abu Lughod notes, contradicts the views that Eastern cultures provided an 'inhospitable environment for merchant-accumulators and industrial developers.'[298]

Further stimulus to trade by the faith, and an intricate link between faith and trade is the fact that quite early in Islam, Muslims were bound to a strict code and practice of trade as summoned in the Qur'an. The summon to record commercial deals, loans, etc is clearly stated in the religious text, which goes:

> 'Be not averse to writing down (the contract) whether it be small or great, with (record) the term thereof. That is more equitable in the sight of Allah and more sure for testimony, and the best way of avoiding doubt between you… and have witnesses when ye sell one to another, and let no harm be done to scribe or witness.' (Qur'an II; 282 ff)

It is, thus hardly a trait of Muslims innate abilities to develop great skills in commerce, from the early stages recording companies and associations, loans, accounts, and making contracts; they simply had to abide by the directives of their faith, and after centuries they perfected the practice.

Udovitch does note how Islamic law and customary practice provided merchants and traders with the commercial techniques to structure and

[293] O.R. Constable: *Trade and Traders*; op cit; p. 80.
[294] A. Pacey: *Technology;* op cit; p. 12.
[295] Wang Gungwu: *Transforming the Trading World of Southeast Asia*; op cit.
[296] F. Hirth and W.W. Rockhill. 1911.; Ibn Batuta. 1983: *Travels in Asia and Africa, 1325-1354*. (London: Routledge and Kegan Paul (Reprint of first edition published in 1929). in Wang Gungwu: *Transforming the trading*.
[297] Van Leur 1955; Hall 1985; Briggs 1951; Dumarcay 1985; Stierlin 1984; in Wang Gwugu: *Transforming the Trading*; op cit.
[298] Janet L. Abu-Lughod: *Before European Hegemony* (Oxford University Press, 1989), p.364.

facilitate trade and exchange.[299] Long before the West, Udovitch explains, Muslim merchants had at their disposal accepted legal mechanisms for extending credit and for transferring and exchanging currencies over long distances such as the *suftaja*, or letter of credit, which allowed a merchant to advance or transfer a sum of money to a business associate at some distant place with 'the full confidence that the transfer would be expeditiously accomplished.'[300] Some 10th-11th century letters of credit were for the huge sum of 40,000 dinars in the Saharan oasis of Sijilmasa, and many examples of such letters, found at Cairo Genizah,[301] confirm that these instruments of credit were always scrupulously and strictly honoured;[302] just as stipulated in the religious text.[303]

By stimulating these forms of payment, and confidence in them, especially in their most advanced form, known to us as the cheque, Islam contributed decisively to the rise of modern banking and global trade systems. The cheque, in Arabic *Saqq*, as Udovitch explains, is 'functionally and etymologically the origin of our modern cheques.'[304] The use of saqq was born out of the need to avoid having to transport coin as legal tender due to the dangers and difficulties this represented; the bankers took to the use of bills of exchange, letters of credit, and promissory notes, often drawn up so as to be, in effect, cheques.[305] By the 10th century, already, it was customary to pay debts not in cash only, but to settle them by means of letters of credit.[306] We hear of a man on a long journey with two servants and a guide, whose only earthly riches consisted of two letters of credit consisting of 5,000 Dinars.[307] Money presents were also bought from the Ahwaz province for the Caliph's mother in the form of a bill for the amount of 3,000 Dinars.[308] There are countless accounts collected from the papyri by Becker to highlight the widespread use of such forms of payment.[309] The bankers benefited from

[299] A.L. Udovitch: Trade, in the *Dictionary of the Middle Ages*; op cit; vol 12; pp. 105-8; at p. 106.
[300] Ibid.
[301] See S.D. Goitein: *A Mediterranean Society*; op cit.
[302] A.L. Udovitch: Trade; op cit; p. 106.
[303] Qur'an: ii.282; iv.33.
[304] A. Udovitch: Trade; op cit; p. 106. See also A. Udovitch: *Bankers Without Banks; The Dawn of Modern Banking* (N. Haven; Yale University Press; 1979).
[305] L. Massignon in G. Wiet et al: *History*; op cit. at p.336.
[306] W. Fischel: The Origins of Banking in Medieval Islam: *Journal of the Royal Asiatic Society (JRAS)*; 1933; pp. 339-52; and pp. 569-91, p. 574.
[307] Tanukhi: *Faraj ba'd ash Shidda*; i. pp. 104-5; in W.Fischel: The origins; p. 575.
[308] *Ibid;* p. 105.
[309] H.C. Becker: *Papyri Schott-Reinhard*,(Heidelberg; 1906), vol 1; p. 11.

this service, evidence showing the reception of a commission for cashing a *sakk;*[310] the commission rate seeming to be of one dirhem for every dinar.[311] The benefits for the trader, however, far outstripped the payment of commission. The purpose of this method was to convey money from place to place, the tradesman able to carry large amounts to distant places without incurring the risk, which in the case of cash was considerable in those days.[312] Goldschmidt explains that the essence of a bill transaction is the real or ideal movement of sums of money.[313] And according to the conception of medieval law a difference of place between the remitter and remittee is indispensable to a bill of exchange.[314] At the city of Basra, in Iraq, by the mid-11th century, anybody could deposit their assets with a changer or banker who handed over a receipt.[315] Any subsequent purchase was then made by means of a draft on the banker, who honoured it when presented by the vendor. 'Such drafts on bankers were the merchants' exclusive currency.'[316] The effect of such methods is easy to understand; it simplified the manifold mercantile relations, and was very useful in the rapid and safe settlement of business transactions.[317] In promoting the concept of the bill of exchange-sakk, or cheque, the Muslims thus made the financing of commerce, especially inter-continental trade possible.

The development of Islamic banking, just alluded to, was early, and institutionally goes back to the time of Harun al-Rashid (r. 786-809). The bankers did not just take charge of deposits and administer funds, they also transmitted money.[318] Under this highly developed banking system, a Muslim businessman could cash a cheque in Canton on his bank account in Baghdad.[319] The main role was played by Jewish bankers who, in the entourage of both caliph and ministers in Baghdad, were entrusted with the keeping of both the jewels of the crown and prisoners of the state.[320] Subsequently, under Caliph Muqtadir (r. 908-932), the State Chancellery granted the title of Court bankers (*Jahabidhat al-Hadra*) to two or three

[310] W. Fischel: The Origins of Banking in Medieval Islam; op cit; p. 578.
[311] Ibid; note 4; p. 578.
[312] Ibid; p. 575.
[313] L. Goldschmidt: *Universalgeschichte des Handelreschts* (Stutgart; 1891), pp. 403-4.
[314] Ibid.
[315] G. Wiet et al: *History*; op cit; at p.336.
[316] Ibid.
[317] W. Fischel: The Origins of Banking in Medieval Islam; op cit; p. 575.
[318] Ibid; p. 574.
[319] J. Glubb: *A Short History;* op cit; p.105.
[320] Passion d'al-Hallaj; Paris, 1922, 1922, p. 266 in Louis Massignon: l'Influence de l'Islam au Moyen Age sur la formation de l'essor des banques Juives; *Bulletin d'Etudes Orientales* (Institut Francais de Damas; 1931), vol 1; pp 3-12; at p. 3.

Jewish bankers in Baghdad.[321] In fact the development of international banking,[322] Massignon explains, has origins with that Jewish element serving the Abbasid Caliphate in the 9th century.[323] That was about five centuries before a banking system of worth appeared in Western Christendom.[324]

The pioneering Islamic role in the globalisation of trade owes much to other factors intricately associated with Arabo-Islamic culture, one such factor being risk taking. Every economic venture requires a certain amount of risk, and the greater the lure for profit, the more the risk undertaken. The concept of risk derives from the Arabic 'Rizk' (bounty), which is even stronger than profit. In no culture would economic venture and bounty seem so closely associated than in the Islamic. In tracing the history of commerce, and wealth creation, Peter Jay seized on this particular element to highlight the decisive role of Islamic civilisation in expanding international trade, via the techniques already described, and most of all by associating both concepts of risk taking and bounty.[325] Islam thus replaced the fulfilment of localized needs with profit through large commercial exchanges; and the search for ever higher profit demanding increased risk taking. The fundamental reason why risk of capital is the child of Islam is simple: Islam forbids the hoarding of money for the sake of lending it in return for interest on it. Interest is banned in Islam. Thus, for any Muslim with money, the need is to invest it in person, or via another party.[326] This way, capital is always circulating rather than remaining static, maximizing its uses. Besides, by forbidding interest on loans, Islam makes available, and freely, the required capital for those eager for economic venture, and for risk takers. There is no such heavy burden upon the investor of having to borrow at high interest, or having to repay crippling interest on loans.

Related to the last point is what is known in medieval Europe as the commenda, which has its Arabic in qirad.[327] This was a form of agreement by which an investor advanced capital or merchandise to an agent-manager who was to trade with it and then return to the investor the principal and a previously agreed share of the profits; keeping the other

[321] H. Sabi, *Kitab al-Wuzara*, ed. Amedroz (Leyden, 1904) in Louis Massignon: l'Influence. p.5.
[322] See also:
W. Fischel: The Origins of Banking in Medieval Islam; op cit; pp. 569-91.
[323] L. Massignon: l'Influence de l'Islam; op cit; p. 4.
[324] Ibid.
[325] P. Jay: The Road to Riches; *BBC;* August; 2000.
[326] See for instance: A. Udovitch: Credit as a mean of investment in medieval Islamic trade; *Journal of Economic and Social History of the Orient* (JESHO); 1967; pp 260-4.
[327] A.L. Udovitch: Trade, in *Dictionary of the Middle Ages*; op cit; p. 106.

share to himself. If the venture failed, the financial loss was incurred by the investor alone; the agent losing his time and effort. The commenda, thus, had the advantages of both loan and partnership. As in a partnership, profits and risks were shared, and as in a loan, there was no liability for the investor beyond the sum of money handed over to the agent.[328] The last point, Udovitch points out, being especially important in view of the very strict Islamic prohibition of usury.[329]

The adequate balance between free exchange and economic regulations was secured via the office and function of the Muhtasib (The State Inspector), who ensured that activities and institutions functioned within the appropriate code of conduct. Arnold explains how the duties of the Muhtasib consisted in preventing breaches of the civil and religious law, in protecting slaves from excessive physical burdens, and punishing careless owners of beasts of burden.[330] These duties extended to trade and other commercial functions. The officials under the Muhtasib visited merchants and druggists so as to prevent the use of false weights and measures, or the sale of damaged food and adulterated medicines, and the overcharging and cheating of purchasers.[331] The treatise by the Egyptian Abd al-Rahman Ibn Nasr (12th century), difficult to date precisely, was composed for the use of the Muhtasib, containing most particularly information on weights and measures.[332] Its purpose was essentially to prevent frauds and regulate commercial transactions.[333] In his *Handbook for the Muhtasib,* Ibn al-Ukhuwwa (d.1329), insists, that 'watch must be kept on the fryers of cheese, not just for the purity of the product, but above all for its safety.[334] The Muhtasib's authority was enforced by fines and scourging, and from his decision there was no appeal.[335]

Most such early Islamic ground breaking accomplishments are to be found carried to the Christian West, via the Italians, in subsequent centuries.

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[328] Ibid.
[329] Ibid.
[330] Sir Thomas W. Arnold: Muslim Civilisation during the Abbasid Period: in *The Cambridge Medieval History*, Vol IV; Edited by J. R. Tanner, C. W. Previte; Z.N. Brooke (1923), pp 274-98, at p.283.
[331] S.P. Scott: *History;* op cit; Vol II, at p.638.
[332] G. Sarton: *Introduction to the History of Science*; 3 vols (The Carnegie Institute of Washington; 1927-48), vol 2; p.298.
[333] Ibid.
[334] *Ma'alim al-qurba*, ed, and translated R. Levy (London, 1938), pp 162-163 (tr. p.40); in G E. Von Grunebaum: *Medieval Islam* (The University of Chicago Press, 1954), at pp.217-8. and p. 165.
[335] S.P. Scott: *History;* op cit; vol 2; p.638.

b. The Islamic Impact:

Islamic banking impacted directly on the West via commercial transactions between the East and the Christian world.[336] By an odd coincidence, it is precisely the Italian cities, which, amongst all Western nations, traded with Islam, which first brought to the Christian West trading mechanisms. The Italian port towns of Genoa and Venice, in particular, maintained an intense trade with Anatolia as well as with the Fertile Crescent, Egypt, and North Africa, and because of that were able to learn from their Eastern counterparts many of the institutional arrangements that facilitated long distance and cross-societal trade.[337] The strong Italian presence in the East during the crusades contributed considerably to such transfers. Erbstosser notes that some such transfers included rationalised calculating methods for book keeping and the introduction of a simplified system of payment in the shape of cheques and bills of exchange.[338]

Other than the crusades, there was the western source of influence: the Italians also keeping the strongest trading links with Muslims in Spain and North Africa, which have been well documented by Constable, and above all by Mas de Latrie.[339] In 1133, for instance, a delegation of Almoravid high dignitaries travelled to Pisa and signed a major agreement with the Republic.[340] During the second half of the 12th century, Genoa and Pisa sought to extend their commercial powers through treaties with Muslim rulers in Valencia, Denia and the Balearics.[341] Both cities likewise negotiated with the Almohads for trade privileges in their domains.[342] The Genoese

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[336] See:
-D.Abulafia: The Role of Trade in Muslim-Christian contact during the Middle Ages in *The Arab Influence in Medieval Europe*; Ed D.A. Agius; R.Hitchcock (Ithaca Press, Reading, 1994), pp 1-24.
-M. Amari: *I Diplomi arabi del reale archivio Fiorentino* (Florence, Lemonnier, 1863).
- M.L. de Mas Latrie: *Traites de Paix et de Commerce, et Documents Divers, Concernant les Relations des Chretiens avec les Arabes de l'Afrique Septentrionale au Moyen Age* (Burt Franklin, New York, Originally Published in Paris, 1866), vol 1; p.xv.
[337] Janet L. Abu-Lughod: *Before European Hegemony* (Oxford University Press, 1989), p.67.
[338] M. Erbstosser: *The Crusades;* op cit; pp. 202-3.
[339] O. R. Constable: *Trade and Traders*; op cit;
M.L. de Mas Latrie: *Traites de Paix et de Commerce*, op cit.
[340] M.L. de Mas Latrie: *Traites de Paix*; op cit; p.36.
[341] *Liber iurium reipublicae genuensis*; ed M.E. Ricotti, *Historia patria monumenta*, vii; pp. 152-3; see also M. Amari *I Diplomi arabi*; op cit; pp. 239-40.
[342] O.R. Constable: *Trade and Traders*; op cit; p. 43.

may have come to terms with the Almohad caliph Abd al-Mumin as early as 1153 (shortly after the Almohad arrival in Spain), and an alliance was certainly in place by 1161.[343] Abd-Al Mumin, the first Almohad ruler, had also in the year 1153 or 1154 concluded a treaty with the Republic of Genoa to secure peace and good rapports between their subjects.[344] In 1166, that is at the height of the crusades, Abu Yakub Yusuf, son of Abd-Al Mumin, gave back to the Pisans the franchises and possessions they had before in Africa, and recognised their right of funduq at Zouila, the main outskirt of El-Mehdia, mostly inhabited by European merchants.[345] Almohad treaties with Genoa appear to have been renewed at roughly fifteen year intervals, and generally included clauses guaranteeing safe conduct for shipping, tariff reductions for Genoese traders, and the right to maintain funduqs in Almohad ports.[346] Similar treaties were drawn up between the Almohads and Pisa in the late 12th century, Pisa, though, remaining less favoured than Genoa.[347] It is through the Pisan colony in North Africa (in Bejaia, specifically), as will be seen further on, that the Christian West acquired the first knowledge of mathematics for commerce, via Leonardo Fibonacci.[348]

The Jewish communities, too, played a fundamental part in such dissemination of ideas, taking their practice from the Muslim milieus into that of their communities in the Christian West, especially as Jewish bankers associated themselves with others from their own community,[349] to form groups of investors willing to support large ventures that included regular caravan journeys and maritime expeditions to Africa and India and China.[350] Kramers notes how next to the knowledge of the bill of exchange, the conception of the joint stock company was acquired by the partnership of Muslim and Christian Italian merchants.[351]

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[343] Ibid.
[344] M.L. de Mas Latrie: *Traites de Paix;* op cit; p.47.
[345] Manrangone, *Chron. Pis*, ed. Bonaini. in M.L. de Mas Latrie: *Traites de Paix*. p. 48.
[346] H.C. Krueger: Genoese Trade with Northwest Africa in the 12th century; *Speculum;* 8; 1933; p. 379.
[347] O.R. Constable: *Trade and Traders;* op cit; p. 43.
[348] See: D.E. Smith: *History of Mathematics* (Dover Publications; Inc; New York; 1923; reedited 1951), p. 216.
[349] Jacob Mann: *Responsa des geonim*, Mesopotamiens, ap.Jew. Qart Rev., 1917-1921, in Louis Massignon: l'Influence de l'Islam; op cit; p. 6.
[350] L. Massignon: l'Influence de l'Islam. p. 6.
[351] J. H. Kramers: *Islamic Geography and Commerce;* extracted from The Legacy of Islam; edited by Sir Thomas Arnold and A. Guillaume (Oxford; 1931); pp. 79-106; reprinted in *The Islamic World and the West;* Edited by A.R. Lewis; op cit; pp. 66-78. at p. 77.
R. and D. El Mallakh: Trade and Commerce, in *The Genius of Arab Civilisation,* J. R. Hayes Editor; Source of Renaissance (Phaidon, London, 1976), pp 193-205; at p. 203.

Already noted is how Islam provides a legal/legislative procedure for commercial transactions.[352] These procedures were widened to include not just Muslim inter-trading but also trading with non Muslims. Amari has gathered 84 original documents, 41 diverse pieces all, related to the Maghrib, many in duplicate and original contemporary text, relating to exchanges between Muslims and Christians,[353] the oldest dating from 1150.[354] Wiet et al. note how oral precedents became committed to standardised written forms; notarial practice evolving in Italy in the 11th century and spreading through southern France and Spain from the middle of the 12th. This has afforded private individuals the opportunity, of which they were not slow to take advantage, of ensuring legal validity for their smallest transactions.[355] Kramers also observes that the treaties, that Western nations concluded with Muslim rulers, and the institution of consular representatives in eastern ports, were important stages in the development of the rules that nowadays govern international trade.[356]

The Islamic impact on modern trade and finance is also obvious through the linguistic legacy from Arabic on fundamental concepts and institutions such as arsenal, Magasin, traffic, tariff, douane (customs), aval etc. The impact is not just, indeed, as has been the unfortunate practice till now on the part of most historians/specialists in Islamic culture, to mention them whilst passing, or see them in their linguistic form, but much beyond. Such expressions, indeed, relate to or express fundamentals upon which the whole modern system of trade and exchange rests. The word saqq leading to cheque has already been examined, and it is worth adding that the German and Dutch words for the same thing (Wechsel, wissel) also derive from Arabic.[357] No need here to dwell too long on a word such as traffic, for instance, from the Arabic *tafriiq*, meaning 'distribution,' which is the basis upon which all exchanges are based. The focus of the World Trade Organisation is indeed on the free movement of goods as the basis of prosperity for all. 'Magazine', particularly in the sense of a storehouse for goods, comes from the Arabic, the Arabic plural *makhazin* being adopted as a singular by the Italian traders of the late Middle Ages (e.g. Genoa or Venice), either direct from an Arabic-speaking country like Egypt or, more likely, from Turkey or Persia, where Arabic plurals were

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[352] A.L. Udovitch: Trade, op cit.
[353] M. Amari: *I Diplomi arabi;* op cit.
[354] M.L. de Mas Latrie: *Traites de Paix;* op cit; p.xv.
[355] G. Wiet et al: *History*; op cit; p.474.
[356] J.H. Kramers: Geography and Commerce; in *The Legacy of Islam,* op cit; at p. 105.
[357] Ibid.

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It was an early development in Islam to relate scientific effort to practical demands, and this will be amply demonstrated in the following part on sciences. Here, Rosen in his 19th century translation of al-Khwarizmi's (780-850) algebra, makes the point that al-Khwarizmi intended to teach:

> 'What is easiest and most useful in arithmetic, such as men constantly require in cases of inheritance, legacies, partition, lawsuits, and trade, and in all their dealings with one another…'[363]

Al-Khwarizmi's is hardly the sole treatise dealing with the issue. Sarton mentions four Spanish Muslim works on *mu'amalat* (Commercial Dealings Involving Arithmetic) that include works by Al-Majriti (d 1007) wherein it is said that he wrote a book on the whole of the science of numbers which is called among us *al-mu'amalat*. Al-Zahrawi (936-1013), al-Majriti's contemporary, wrote *Kitab sharif fi'l mu'amalat al tariq al-burhan* (the Noble Book on Mu'amalat in the Demonstrative Manner). The other two were Al-Tunbari (d. 1025) and Ibn al-Samh.[364] Sarton insists that due to the fact that all four works came from Spanish Islam, they might well have been very influential on the development of

[358] G. M. Wickens: 'What the West borrowed from the Middle East,' in *Introduction to Islamic Civilisation*, edited by R.M. Savory (Cambridge University Press, Cambridge, 1976), pp 120-5; at p. 121.
[359] Ibid.
[360] Ibid.
[361] M.L. de Mas Latrie: *Traites de Paix*; op cit; p.84.
[362] J.H. Kramers, Geography and Commerce; op cit; p. 105.
[363] F Rosen (ed. and trans.), The Algebra of Mohammed ben Musa (1831, reprinted 1986) in entry on al-Khwarizmi by John J O'Connor and Edmund F Robertson: *Arabic Mathematics*, op cit.
[364] G. Sarton answering Query 23 on Arabic commercial arithmetic; *ISIS*, vol 20; pp. 260-2; p. 261.

medieval commerce and the transmission of Muslim commercial methods to the Christian world; a transmission which is very much substantiated by the presence of many Arabic words in the Spanish vocabulary.[365] However, it was not the sole route of Islamic influence upon the Christian West; the best known being, once more the Italian route, via Leonardo Fibonacci and the North African route. Leonardo Fibonacci's father, during his trading exchanges with the North African coast, had discovered the superiority and advantages of the Islamic accounting system for commercial purposes.[366] He sent his son Leonardo to Bejaia on the North African coast to acquire such skills.[367] And the resulting outcome is Leonardo's *Liber Abaci* of 1202, divided into fifteen chapters, some chapters dealing specifically with, as follows: Chapter 8: Prices of goods; 9: Barter; 10: Partnership; 11:Alligation; 12: Solutions to Problems.[368]

There was a rich Islamic literature about, and defining, economic activity, besides establishing early known economic laws. The early (11th century) Al-Dimashqi's guide: *Kitab al-Ishara* (The Book of Guidance)[369] begins with an essay on the true nature of wealth, and then proceeds to discuss the necessity of money; how to test a currency; how to evaluate commodities; their prices; how to discern good from defective merchandise; investment in real estate; handicrafts and manufactures; advice for salespeople; the advantages of business; the different types of merchants and their duties; how to avoid fraud; how to keep records, wealth protection, and so on and so forth….[370] Information of interest is also found in the treatise on wares and their forgeries by Ja'afar ibn Ali of Damascus, and the manual for police officers in charge of markets by the Egyptian Ibn Nasr.[371] Ja'afar's work, written in 1175, was primarily a commercial treatise dealing with forgeries and showing how to detect and avoid them.[372] Other writings on the subject are outlined by Lewis.[373] They

[365] Query 23; p. 261-2.
[366] See entry on Fibonacci in *Dictionary of Scientific Biography*; vol 4; Charles Coulston Gillispie Editor in Chief; Charles Scribner's Sons; New York; 1970 fwd.; W. Montgomery Watt: *The Influence of Islam on Medieval Europe* (Edinburgh, 1972), etc.
[367] W. Montgomery Watt: *The Influence of Islam*. pp. 63-4.
[368] D.E. Smith: *History of Mathematics*; op cit; p. 216.
[369] Al-Dimashqi: *Mahasin al-Tijara*; trad. H.Ritter, Ein arabisches handbuch der handelswissenschaft; in *Der Islam*; vol VII; 1917; pp 1-91.
[370] R.D. Mc Chesney: Ad-Dimashqi in *The Genius of Arab Civilisation*, (J. R. Hayes Ed) ; op cit; p 206.
[371] G. Sarton: *Introduction;* op cit; Vol II, p.47.
[372] Ibid; p.298.

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[363] F Rosen (ed. and trans.), The Algebra of Mohammed ben Musa (1831, reprinted 1986) in entry on al-Khwarizmi by John J O'Connor and Edmund F Robertson: *Arabic Mathematics*, op cit.
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[368] D.E. Smith: *History of Mathematics*; op cit; p. 216.
[369] Al-Dimashqi: *Mahasin al-Tijara*; trad. H.Ritter, Ein arabisches handbuch der handelswissenschaft; in *Der Islam*; vol VII; 1917; pp 1-91.
[370] R.D. Mc Chesney: Ad-Dimashqi in *The Genius of Arab Civilisation*, (J. R. Hayes Ed); op cit; p 206.
[371] G. Sarton: *Introduction;* op cit; Vol II, p.47.
[372] Ibid; p.298.

include the early (9th century) treatise *Al-Tabassur bi'l Tijara*, which discusses the qualities, values and ways of evaluating gold, silver, pearls and precious stones, textiles, skins and other commodities, and also lists goods imported from the provinces of other Islamic lands and abroad.[374] Another work of interest is a 13th century Syrian treatise which focuses on trickery and fraud; including false prophets; spurious priests; alchemists; astrologers; dishonest grocers; cooks; money changers; physicians and other trades and professions.[375] This literature, Lewis sums up, is 'by civil servants for civil servants,' which vary from 'the manuals dealing with the working of one office or official to encyclopaedias of bureaucratic usage and procedure.' These works dealt with finance, revenue, financial administration, expenditure, and also tolls and customs, land tax, wages, prices, trade and manufacture etc.[376] Lewis, here, raises the interesting point:

> 'It would be easy to assemble other traditions, and writings of ascetic tendency, that say just the opposite and condemn commerce and those engaged in it. It is, however, noteworthy that centuries before Christian writers were prepared to defend and define the ethics of commerce against ascetic criticism, Muslim writers were willing to do so, and that even a major theologian like al-Ghazali (d.1111) could include, in his religious writings, a portrait of the ideal merchant and a defence of commerce as a way of preparing oneself for the world to come.'[377]

This form of literature had its impact on the Christian West, though, and once more, on the Italians. Thus, Al-Dimashqi's *Kitab* shows a very close relationship, in technique and approach to the subsequent Pegalotti's *Practica della Mercatura*.[378] A great deal of the merchandise mentioned was the same, as was a lot of the technical terminology, the advice to businessmen, and many of the forms of business relationships.[379]

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[373] B. Lewis: Sources for the Economic History of the Middle East; in M.A. Cook ed: *Studies in the Economic History of the Middle East* (Oxford University Press; London; 1970), pp. 78-92.

[374] Al-Jahiz: *Al-tabassur bi'l tijara*; ed hasan Husni Abd al-Wahab; *Revue de l'Academie Arabe de Damas*; xii; 1932; reprinted Cairo: 1935; Fr translation by C. Pellat: *Le Kitab al-Tabassur; Arabica*; I; 1954; pp. 153-64. Lewis notes (p. 89), note 32 that the attribution to Jahiz is possibly an error.

[375] Al-Jawbari: *Al-Mukhtasar fi Kashf al-Asrar* (Cairo; 1934).

[376] B. Lewis: Sources for the Economic; op cit; at p. 90.

[377] Al-Ghazali in B. Lewis: Sources for the Economic; op cit; at p. 88.

[378] N. Stilman (discussion) in *Islam and the Medieval West*; In K. I. Semaan; ed; op cit; p. 152.

[379] Ibid.

4. Means and Resources:

A variety of means and resources that could have been placed under this heading have already been looked at. Here focus is on other forms of payment not examined above, and the role of maritime transport.

a. Currencies and Forms of Payment:

Rosenberger notes how the Muslim realm was never perfectly united geographically and politically, and that many local rulers minted their own currencies.[380] The early caliphs used Byzantine and Persian money, but in 695, the Umayyad Caliph Abd-al-Malik struck an Arab coinage of gold dinars and silver dirhems.[381] The Umayyad Dynasty disappeared in the East but was transferred to Spain. Spanish currency consisted of the Dinar (of gold), which was equal to two dollars (early twentieth century value); the dirhem (of silver), equal to twelve cents; and various small pieces of copper that fluctuated in value.[382] In terms of its weight in gold, Gerspach informs us a Dinar weighs between 4 and 4.20 grams, the gram of gold.[383]

The usage of currencies and their valuation were studied by Al-Muqaddasi in his treatise *Ahsan at-Taqasim fi Ma'arifat al-Aqalim* (The Best Divisions in the Knowledge of the Climes).[384] He looks at such currencies in every part of the Muslim world, their design, value, multiples, and sub-multiples, their equivalents in goods and merchandise, and so on. Thus, for the Maghrib, he says:

> 'In all the provinces of this region, the standard is the *dinar*, which is lighter than the *mithqal* by a *habba*, that is to say a grain of barley. The coin bears an inscription in the round. There is also the small *rub'*, (quarter of a *dinar*); these two coins pass current by number, [rather than the weight]. The *dirhem* also is short in legal weight. A

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[380] B. Rosenberger: La Pratique du commerce; in *Etats, Societes*; op cit; pp. 245-274; p. 260.

[381] A. Durant: *The Age of Faith*; op cit; p. 208.

[382] S.P. Scott: *History;* op cit; vol 2; p. 636.

[383] Gerspach: *L'Art;* op cit; p. 97.

[384] Al-Muqaddasi: *Ahsan at-taqasim fi Ma'rifat al-Aqalim*; from the partial French translation by A Miquel, Institut Francais de Damas, Damascus, 1963.

> half *dirhem* is called a *qirat*; there is also the quarter, the eighth part, and the sixteenth part which is called a *kharnuba*… All of these circulate by number [rather than by weight], but their use thus does not bring any reduction in price.'[385]

Al Muqaddasi, incidentally, also looks at weighs and measures, and for the same region, he informs us that:

> 'The *sanja* (counterpoise weights) used are made of glass, and are stamped just as described about the *ratls*. The *ratl* of the city of Tunis is twelve *uqiya* (ounce), this latter being twelve *dirhems* (weight).'[386]

The smallest weight Muslims used in trade was the grain of barley, four of which were equal to one sweet pea, called Arabic carat; which is still in use as a unit of weight, and of precious metals (eg. so many carats fine).[387]

Forms of payment varied according to the geographical boundaries, but were mostly affected by the nature of the transaction itself. Briefly, payment for large transactions was often on credit, subsequent to the writing of a contract between the parties involved, the buyer acknowledging his debt; which could be settled in stages. Payments could also be made in kind, by cheque or by letter of credit; gold was only used in very large transactions.[388] Payment for small transactions was carried in cash, generally in silver coins, for larger transactions, usage of paper was current, and bills, called *ruk'a,* promises of payment, were written; the cheque, of course, the more common method, aimed at saving the carriage of large amounts.[389] The letter of exchange, already mentioned, in Arabic the *Hawala*, and in Persian the *Suftadja*, was very much in use, and it consisted in merchant A giving merchant B a letter requiring from a third C, residing in a distant place to advance B an amount which A will reimburse in the future.[390] Dates for reimbursement were, of course, agreed in advance.

There have been considerable finds of Muslim coins and currencies in recent history. As stated above, Bolin refers to some large finds, one consisting of more than 11,000 dirhems, in addition to an indeterminate number of fragments, and weighing more than 65lbs, whilst hoards

[385] Ibid; p.215.
[386] Ibid.
[387] J.W. Draper: *History*; op cit; Vol II; p.44.
[388] B. Rosenberger: La Pratique; op cit; p. 261.
[389] Ibid.
[390] Ibid; pp. 261-2.

containing many hundreds or a few thousands of dirhems were common.[391] The geographic distribution of these finds stretches from Scandinavia to Silesia and the Ukraine in the south; and from Schleswig-Holstein and Mecklenburg in the west to the Urals in the east; hundreds of finds containing very large numbers of coins.[392] Although the finds of Islamic coins in the diverse parts of the Western world have received a good deal of attention, focus, generally, has been from a collector's point of view. Though this is an interesting matter, it ought not to surpass in attention the real issue of what Muslim coins tells us about the trade of Islam with the Christian West in the medieval period. These hoards reveal, indeed, the intensity of the flow of currencies,[393] and of course the dense flow of trade between the Muslims and Europe. Hoards, which also point to highly elaborate monetary system, one of the fundamental institutions in the economic life of medieval Near Eastern society.[394]

Muslim gold and silver were widely in use during the medieval era in the Western Christian world. Gold currency spread widely after the Muslim arrival in the 8th century (in Spain) and after, in the form of Muslim coins and local imitations of them, which were fairly common.[395] Northern Christian rulers did not mint their own gold until the 13th century, yet various gold coins were used in the north during the medieval period.[396] Andalusi currency was certainly transported across the frontier from as early as the 8th century.[397] Andalusi dirhems (silver) appear in Christian documents, usually under the guise of *solidos mahometi, solidos de argento Kazimi*, or *solidos hazimi*.[398] Chalmeta has cited twenty two references to these qasimi dirhems dating between 933 and 1078.[399] Such widespread use, Cahen points out, confirms the role of Islamic currency 'infusing new blood into commercial relations.'[400] Within the Muslim world and outside it, fresh monetary currents appeared along the great trade routes, and there was no longer, as

[391] European discoveries of Cufic coins to 1900 are listed in A.Markov: *Topografiia kladovvostochnykh monet*, 1910; in S. Bolin, Mohammed, op cit.
[392] S. Bolin: Mohammed, in *Bedeutung*, op cit, at p.258.
[393] Ibid.
[394] A. S. Ehrenkreutz: Monetary Aspects of Medieval Near Eastern Economic History; in M.A. Cook ed: *Studies*; op cit; pp 37-50; at p. 37.
[395] Bloch, p.13 ff. with bibl. In R.S. Lopez: Mohammed, op cit; pp.14-38.
[396] P. Grierson: Carolingian Europe and the Arabs; the myth of the Mancus; *Revue Belge de Philosophie et d'Histoire*; 32 (1954); pp. 1059-74. p. 1065.
[397] O. R. Constable: *Trade and Traders*; op cit; p. 47.
[398] Ibid; p. 48.
[399] P. Chalmeta: Precisions au sujet du monnayage hispano-arabe; in *Journal of Economic and Social History of the Orient*; 24 (1981), pp. 316-8.
[400] C. Cahen: Commercial Relations; op cit; p.1.

there had been before the Muslims, 'a linear displacement of the mass of metal,' but a completely new pattern, 'in fact a genuine circuit,' according to Lombard.[401] The Muslim world's steady supply of precious metal, and in abundance, stimulated demand and met the needs in great urban centres.[402]

Muslim coins were of high quality, too. The Muslim coinage of Spain, in particular, enjoyed a great reputation for both purity and design.[403] The same reputation was enjoyed by Islamic gold dinars minted elsewhere. Bates notes how the Normans of Sicily struck Arabic gold quarter dinars (called taris by the Italians) for nearly a century after their conquest of the island, whilst Christian France, just as Spain and Italy, also used and imitated the gold coins of the Almoravids (called maravedis).[404]

A subsequent Muslim innovation, the use of paper money, coming via China, was to revolutionise monetary transactions. Paper money was first adopted in north China by the end of the 11th century and in the Chin and Southern Sung territories it was in regular use by the 12th century, although it still coexisted with metal coins.[405] Some paper money was printed in Chinese and Arabic in 1294 at Tabriz via block-printing, a method also of Chinese origin.[406] Evidence of this is provided by a contemporary.[407] As with paper, it was the Muslims, who traded directly with the West, who both generalised the use and spread of this Chinese invention.

b. Maritime Transport and Trade:

'Islam's ancient glories,' according to Braudel, 'were not just its horsemen but also its sailors,'[408] Islam, being 'the society of motion by excellence, which implies sea travel to far places.'[409]
Braudel's view, however, conflicts with the overwhelming majority of Western historians on Islam, who deny Islam any naval expertise or interest. Hartmann, for instance, writes:

[401] M. Lombard: *The Golden*; op cit; p. 117.
[402] Ibid.
[403] S.P. Scott: *History;* op cit; vol 2; p. 636.
[404] M.L. Bates: Mints and Money: *Dictionary of the Middle Ages*; op cit; pp 421-4. p. 423.
[405] Janet L. Abu-Lughod: *Before European Hegemony;* op cit; p.333.
[406] G. Sarton: *Introduction;* op cit; Vol II, p. 764. D. Hunter: *Papermaking;* op cit; p.474.
[407] G. Sarton: *Introduction,* Vol II, p. 764.
[408] F.Braudel: *Grammaire des Civilisations* (Flammarion, 1987), p.88.
[409] Ibid; p.95.

> 'Islam has as a rule been afraid of the sea; from the very beginning it was impressed with a sense of the supremacy of the unbelievers on the ocean and made practically no efforts to dispute their domination.'[410]

Such was the fear of the sea by Muslims, and such was Muslim ineptness in the field, according to Western historians, it largely accounted for their military inferiority.[411]

Historical evidence once more shows the very opposite. Beginning briefly with the latter point on maritime warfare. A fleet of three hundred Muslim vessels, Levi Provencal notes, was charged to bring into order the rebellious coastal populations of Majorca and Minorca in 848-9.[412] Four years earlier, following Viking attacks on Seville, the Caliph, 'Abd Errahman II decided to have a strong fleet built, and shipyards were erected.[413] Under the rule of Al-Hakam II (r. 961-76), a Muslim fleet was able to catch a Viking formation, not far from Silves and decimate it.[414] A great fleet was used by the late 10th-early 11th ruler, Al-Mansur, for his campaigns off the Catalan and Galician coasts in 985, and then in 997; facts, which Levi Provencal notes, highlight the power and potency of the Muslim navy.[415] Fahmy, for his part, devotes the bulk of his work to tracing Islamic arsenals (arsenal=*dar al-sina'a*) and naval centres.[416] Arsenals go back very early, to the rule of Caliph Mu'awiya (661-680), under whose orders, a number of warships were built in Alexandria.[417] The capture of Alexandria was, in fact, a crucial factor in the development of Muslim sea-power.[418] It is also worth noting that the Syrian fleet based in Tartus had become 'the terror of the Aegean' by the end of the 10th century.[419] And instances can be multiplied to highlight, once more, the wide discrepancies that exist between mainstream historical writing, which belittles Muslim naval capacities, and historical reality, which shows great Muslim naval powers.

[410] M. Hartmann: China; *Encyclopaedia of Islam*; 1st series; Vol 1; Brill; Leiden; 1913; pp. 839-54; at p. 844.
[411] Such as found in C. Hillenbrand: *The Crusades, Islamic Perspectives* (Edinburgh University Press; 1999), pp. 556 fwd.
[412] E. Levi Provencal: *Histoire*; op cit; p.107.
[413] Ibid.
[414] Ibid; p.108.
[415] Ibid.
[416] A.M. Fahmy: *Muslim Naval Organization*; Second edition; Cairo; 1966. chapters one and Two.
[417] Sebeos quoted by Buttler; p. 113; in A.M. Fahmy: *Muslim*; op cit; p. 28.
[418] A.M. Fahmy: *Muslim;* p. 28.
[419] Brooks: Byz. Zeit. 1913; p. 384 in A.M. Fahmy: *Muslim*; p.61.

Aside from its military role, the Islamic navy played a crucial part in maritime trade. Descriptions of contemporaries and chants by ancient poets spoke of great ships, heavily laden, and light feluccas mingled.[420] Throughout the medieval period, Muslim ships and merchants dominated the circuit between the Gulf-Red Sea and the south Indian coasts, where they were joined by Indian ships that shared with the Chinese dominion over the second circuit to the Strait.[421] Muslim traders visited the Red sea on their route to the Mozambican coast, Ethiopia, and Zanzibar and South Africa, and as early as the 10th century, they had a colony in Madagascar.[422] On the Tigris in Iraq in the 12th century, cane rafts were in great use, and in Egypt, commercial transport was very dense on the Nile and the canals.[423] To the West, in Spain, African boats also used to visit regularly the Spanish ports, delivering and carrying both goods and travellers.[424] Goitein has collected details of about 150 ships operating in the Mediterranean and the Nile, many ship owners were based in Tunisia.[425]

The dominating role of Muslim medieval shipping is highlighted by the fact that Arabic documents provide a wealth of maritime vocabulary and technical names for the vessels, such as those that carried merchants between Andalusi ports and other areas of the Mediterranean.[426] Andalusi Muslim sources cite a variety of vessels. For example, in a sample contract for the hire of boats, the jurist Jaziri (d. 1189) referred to *shani, kharraq, dughaiyas,* and *zawraq* (respectively translatable as a galley, sailing boat, transport vessel, and skiff).[427] Mediterranean vessels varied in size, and a ship described as 'large' may have held several hundred passengers.[428] In the middle of the 12th century, Usama B. Munqidh mentioned a ship carrying four hundred pilgrims from the Maghrib to the eastern Mediterranean.[429] Geniza letters from the next century confirm

[420] In G. Wiet et al: *History*; op cit; at p.325.
[421] Janet L. Abu-Lughod: *Before European Hegemony*, op cit; p.274.
[422] F. Braudel: *Grammaire*; op cit.
J. Spencer Trimingham: *The Influence of Islam Upon Africa* (Longman, Librairie du Liban; 1980).
[423] In G. Wiet et al: *History;* op cit; p.325.
[424] See E. L. Provencal: *Histoire*; Vol iii; appropriate sections for greater detail.
[425] S.D. Goitein: Mediterranean Trade in the Eleventh Century: Some facts and problems; in *Studies in the Economic History of the Middle East*; (Ed M.A. Cook) op cit; pp. 51-62: at p. 59.
[426] O.R. Constable: *Trade and Traders*; op cit; pp. 24-5.
[427] Ibid; pp. 25.
[428] Ibid; pp. 28.
[429] Usama Ibn Munqidh: *Kitab al-Itibar*; Ed H. Derenbourg (Paris; 1886-93), I.2; p. 61.

these numbers. One mentioned a boat travelling to Seville with thirty six or thirty seven Jews and nearly three hundred Muslims, while another referred to a ship bringing four hundred people from Palermo to Alexandria.[430]

A multitude of shipyards were busied in the supply of vessels capable of carrying vast cargo of goods and traders and their beasts, but also capable of crossing long distances.[431] By far, the best description of such shipyards is by Fahmy.[432] Fahmy uses the widest range of contemporary sources to locate and describe Muslim shipyards, and the materials used in ship construction. There is also a very good insight on naval organisation.[433] Sources, especially primary, also help form a more thorough picture on the subject.[434] Levi Provencal, too, offers an excellent picture of Muslim shipping in Spain.[435] Other than Almeria, there were many other Spanish shipyards called either *Dar al-insha* (engineering house), or *Dar sina't al-marakib* (Ship-yards) (or simply *Dar al-sina'a*).[436] Amongst these was Alcacer do Sal, Silves, Seville, Algeciras, Malaga, Alicante, and Denia. At Tortosa, near Catalonia, an inscription shows that a shipyard was set up there under Abd Errahman III in 945.[437] Ibn Jubeir (Ibn Jubayr) (d. ca. 1217) and al-Idrisi (b. 1101) also cite vast shipyards active in Sicily.[438] Shipyards supplying boats for coastal and distant traffic were also found on the North African coast and Egypt.[439] In Morocco, Yaqubi (fl.875) refers to a very large complex at Sos.[440] Egypt, which only harboured two shipyards in Byzantine times, had eight under the Tulunids (9th century,) and their successors, the Fatimids.[441] To the East, Al-Baladhuri (d. 892) mentions a shipyard at Aqqa on the Syrian coast, others were to be added in the same region under Salah Eddin al-Ayubbi (Saladin) (d. 1193) for commercial and also military purposes.[442] Tyre had yards producing racing vessels, and

[430] S.D. Goitein: *Mediterranean society*; op cit; I; p. 315.
[431] As an introduction to the subject, consult, for instance: G. F. Hourani: *Arab Seafaring in the Indian Ocean in Ancient and Early Medieval Times* (Princeton University Press), 1971.
[432] A.M. Fahmy: *Muslim Naval Organization*; op cit.
[433] Ibid; chapter IV.
[434] Ibid; Introduction.
[435] E.L. Provencal: *Histoire;* op cit.
[436] Ibid; pp. 321-2.
[437] Ibid; pp. 320 fwd.
[438] Ibn Jubayr: *The Travels of Ibn Jubayr*; Ed de Goeje (Leyden; 1907); p.327. Al-Idrisi: Description of Italy, p.85.
[439] E. L. Provencal: *Histoire*; op cit; pp. 321-2.
[440] Al-Yaqubi: *Kitab al-Buldan*; tr G. Wiet (Cairo; 1937), p.348.
[441] M. Lombard: *Les Textiles*; op cit; p. 202.
[442] Al-Baladhuri: *Futuh al-Buldhan* (Leyden; Brill; 1866), pp. 117-8.

was not alone among the towns of the Syrian coast in this activity.[443] Fahmy provides a long list of such shipyards on the Syrian, and also Egyptian coast.[444]

Timber supply plays the basic role in ship construction, a subject well covered by Lombard.[445] When such supply eventually ceased, it caused the demise of the Islamic maritime effort in the East.[446] The loss of Spain by the Muslims in the 13th century was to play a leading role in the beginning of decline of Islamic naval power. The image that Glick offers of the Iberian Peninsula is of a richly forested part; pines growing in the Algarve and Murcia in the south, in the mountains of Cuenca and Albarracín, in the hinterland of Tortosa, and on the island of Ibiza.[447] Oaks were found in vast areas, most particularly at what is now Los Pedroches, a forest of evergreen oaks extending far and wide across mountains and high plateaux to Almaden.[448] Oaks were also found in the Algarve, Extremadura, and New Castile. To the south of the Duero was another great belt of oak, respected by the Muslims as 'a strategic barrier,' and the entire northern Meseta was rich in kermes, evergreen, and holm oaks.[449] Al-Andalus was a major exporter of wood in the Islamic world, shipping timber to Morocco.[450] When Spain (but for the Grenada enclave) was lost in the 13th century, Western Islam lost its principal source of supply of wood. Wood imports elsewhere in the Muslim realm were to become privileged prey to Christian pirate attacks, which eventually, as the last part of this work will show, caused the demise of Islamic shipping in the crucial sea and ocean going age (15-18th centuries).

Other than timber, ship construction depended on the use of materials, also described by Fahmy.[451] These include nails, copper chains, cables, anchors, cushions, pads, sails, etc. Contemporary sources tell of the quantities of

[443] G. Wiet et al: *History*; op cit; p.328.
[444] A.M. Fahmy: *Muslim*; op cit; Chapters one and two.
[445] M. Lombard: Arsenaux et bois de marine dans la Mediterranee Musulmane; in *Le navire et l'Economie maritime du Moyen Age au 18em siecle*; Deuxieme Colloque International d'Histoire Maritime (Paris; 1958), pp 53-106.
[446] I.M. Lapidus: *Muslim Cities in the Later Middle Ages* (Harvard University Press; Cambridge Mass; 1967), W. Heyd: *Histoire*; op cit.
[447] T. Glick: *Islamic and Christian Spain in the Early Middle Ages* (Princeton University Press, 1979), p. 133.
[448] Ibid.
[449] Ibid.
[450] Ibid; p. 134.
[451] M. Fahmy: *Muslim;* op cit; pp 75-85.

materials used and also of the varieties of iron objects.[452] The medieval Muslim Spanish writer on the state inspector, Al-Saqati (fl. end 12th century, or beginning the 13th century), at the end of his manual, details various items (ropes, sails, and the like) that were necessary in order to equip a ship properly, together with materials (including nails and linen) required for ship construction.[453] The use of nails instead of ropes to tie parts of the boats, for instance, was observed by the geographer Ibn Rustah (fl. 903), a major, early, breakthrough in boat construction.[454]

Scores of other innovative, pioneering developments were made by Islamic shipping, developments which opened the way to long distance sea and ocean travel. One innovation was, despite its name, the lateen sail, introduced first in the Indian Ocean and then, via the 'lateen caravel,' in the Mediterranean.[455] The advantage of such sail was to allow ships to beat against the wind, unlike the square rigged galleons of the Mediterranean, which could sail only before the wind. Another early, 8th century, development, was the use of tar instead of oil on the wooden decks to prevent them from leaking.[456] The use of the compass in navigation, of course, was crucial as it guided vessels across 'the trackless waters,' independently of the appearance of the stars (and indicated unerringly the course of the caravan in the Desert).[457] The compass, it ought to be remembered, was a Chinese invention, the Islamic contribution being its use in sea journeys, which opened new options for the movement of goods and traders.[458]

It was Islamic civilisation which spurred large scale exchanges between distant places, a definite landmark in the rise of bulk maritime trade. Trade through international boundaries, Udovitch explains, required substantial investments of capital to purchase goods, and also to transport them, and care (amidst risks so difficult to imagine today) for them until they could be sold.[459] Thus, commercial enterprises involved the partnership of many investors, and in the case of maritime transportation,

[452] Ibid; pp 81-3.
[453] Al- Saqati: Kitab al-Faqih; pp. 71-2; in O.R. Constable: *Trade and Traders*; op cit; p. 117.
[454] Ibn Rustah: *Al-A'alaq-un-Nafisa* (Leyden; 1891), pp. 195-6.
[455] On this: see R and D. El Mallakh: Trade; op cit; at p.204; W.M. Watt: *The Influence; op cit;* pp. 19-21.
[456] Al-Baladhuri: *Futuh al-Buldan*; op cit; pp. 117-8.
[457] S.P. Scott: *History,* op cit, vol 2; p.634.
[458] See *Relations des Voyages faites par les Arabes et les Persans dans l'Inde et a la Chine*, ed. et tr. Langles et Reinaud (Paris, 1845), deux petits volumes, Imprimerie Royale.
[459] A.L. Udovitch: Trade, op cit; p. 106.

a vessel could often be the property of a group of people either as co-owners, or as an association (*shirka*) brought together for that large commercial venture.[460] It was irrelevant whether the crew were of a different ethnic, or religious group from that of the owners. What was relevant, though, and constituted cause for scrutiny, were matters of responsibility over the cargo, compensation for losses, and similar issues, which became the focus of maritime jurisprudence and law.[461] Islamic law, Udovitch points out, was able to reflect the complexities of such large commercial ventures, and provided traders with a variety of means to deal with them.[462] Udovitch does dwell on the intricacies of such Islamic law of the sea, relying on an 11th century Islamic treatise on the subject.[463] A subject also dealt with by Khalileh.[464] In other aspects of maritime legislation, Pardessus has noted that Maghrebi treaties were very much favourable to relations with the Christians, as they allowed allied nations to carry, on their vessels, foreign traders (often from enemy states) and to associate them, in a certain measure, with the privileges which they themselves enjoyed.[465]

5. Exchanges with Asia, Africa and Europe:

Hariri quotes the words of a Muslim tradesman:

> 'I want to take Persian saffron to China, where I heard it fetched a good price; then take Chinese porcelain to Greece, then Greek brocar to India, then Indian steel to Aleppo, Aleppo glass to the Yemen, and Yemeni cloth to Persia.'[466]

These short sentences capture fully the optimism and enterprise of Muslim traders. Up to the 13th century, Muslim trade reached seemingly all parts of the known world, then, and the movements of Muslim traders and their goods stretching far and wide. Lopez notes how:

[460] B. Rosenberger: La Pratique du Commerce; op cit; P. 266.
[461] Ibid.
[462] A.L. Udovitch: Trade; op cit; p. 106.
[463] A. Udovitch: An Eleventh century Islamic treatise on the law of the sea: In *Annales Islamologiques*, Institut Francais d'Archeologie du Caire; Vol 27; pp 37-54.
[464] H. Khalileh: *Islamic Maritime Law* (Leyden; 1998).
[465] M. Pardessus: *Collection des lois maritimes*, 6 vols (Paris; 1828-1847), Vol III, pref., p. LXXXII.
[466] F.Braudel: *Grammaire,* op cit, p. 103.

> 'The Arabs, masters of an empire extending from the Gulf of Gascony to beyond the Indus, involved in commercial enterprises reaching into Africa and Baltic Europe, brought East and West together as never before.'[467]

Muslims established trading posts in Sind and Gujarat, near Bombay, and by the end of the 11th century, Muslim merchants are known to have set up permanent establishments in Hungary, testifying, in the words of Wiet et al.:

> 'Zeal and ability' which Muslim society could call upon in commercial matters.[468]

The vast Muslim coin finds in and around Scandinavia also attest to vast trading links between Islam and Scandinavia across Russian lands as far as Byzantium, or crossing the territory of the Khazars, on towards the Caspian and to Baghdad.[469]

This vast geographical stretch of Muslim trade can be subdivided into two rough zones of activity, Eastern trade, towards India, China and Africa, and Western to the Mediterranean.

a. The Eastern and African Trade:

Travels by Muslim merchants to China had begun in earnest, and merchants have left excellent accounts of them. The first such accounts, dating from the 9th century, were those of Suleyman (851), narrated by Abu Zeid Hassan (in 880),[470] who also added more information procured by other Arabs who had visited China.[471] Abu Zeid speaks of boats sailing for China, departing from Basra and Siraf, whilst Chinese boats (much larger than the Muslims') visited Siraf to be loaded with merchandise brought from Basra. Siraf, on the shores of the Gulf, could accommodate the large vessels and Chinese ships that did not reach as far as Basra. From Siraf, boats sailed to the Arabian coast, Muscat, Oman, and then on to India. En route to China, the merchants carried out more transactions; in the so-called islands of 'Lendjebalous', for instance, they exchanged iron objects for ambergris. The first major Chinese destination was Khanfu (Canton), where Muslim traders had their own establishments.[472] From

[467] In G. Wiet et al: *History*; op cit; p.161
[468] Ibid; p.163.
[469] J. Fontana: *The Distorted Past* (Blackwell, 1995), p.37.
[470] *Relations des Voyages;* op cit.
[471] G. Le Bon: *La Civilisation des Arabes*, op cit; p.369.
[472] In Baron Carra de Vaux: *Les Penseurs de l'Islam* (Geuthner, Paris, 1921), vol 2; pp. 53-9.

Khanfu they went as far as the empire's capital, Khomda; a two month journey. In China, merchants procured a variety of goods, particularly silk and porcelain, to be re-sold to Europe. From China also came iron and steel (and obviously techniques associated with their production).[473] Besides their trade, the merchants also provide many descriptions and other anecdotal stories about the country; China, according to Muslim merchants, being both safe and well administered; laws concerning travellers securing both good surveillance and security.[474]

Muslims had many trading posts in Sind, Gujarat and Bombay; and on their way to India, the travellers used the Red Sea ports of Jar and Jidda and, in the Persian Gulf, Ubullah, formerly Apologos.[475] With India, as with Ceylon, exchanges concerned mainly spices, dyeing materials, indigo, timber products, diamonds and other precious stones, and semi finished steel ores aimed for the centres of Damascus and Toledo.[476] India was also reputed for its finer textile products, mostly manufactured in Bengal and in Cambaye, from local cotton supplies.[477] These fine products found great demand amongst Arabs and Persians, and India supplied the product in huge ship-loads either via Aden or Hormuz.[478] Raw materials were procured from neighbouring parts; from the Malay Peninsula, for instance, Muslims were importing tin.[479]

Foreign colonies of Middle Eastern merchants established themselves earliest on the north-western coast of India where they blended with the local population.[480] By the early days of Islam, the ports of Cambaye and Saymur had already absorbed resident colonies of Arab merchants, some extremely wealthy, as well as sailors from Siraf, Oman, Basra, and Baghdad, whose presence and permanent incorporation through intermarriage, the early 10th century geographer Al-Masudi observed when he sojourned there.[481] The Islamising of Gujarati merchants, which had begun in the first centuries of Islam, intensified at the end of the 12th and beginning of the 13th century with the establishment of the Turkish Sultanate of Delhi.[482] By the mid-13th century, one of the Muslim settlements, Calicut, became the prime port for

[473] Janet L. Abu-Lughod: *Before*; op cit; p. 323.
[474] Carra De Vaux: *Les Penseurs*; op cit; at p. 58.
[475] G. Wiet et al: *History*, op cit, at p. 161.
[476] Compiled from chapter 8 of M. Lombard: *The Golden*; op cit.
[477] W. Heyd: *Histoire du commerce*; vol 2; op cit; p. 705.
[478] Varthema; pp 151; 157 etc in W. Heyd: vol 2; p. 705.
[479] Compiled from chapter 8 of M. Lombard: *The Golden;* op cit.
[480] Janet L. Abu-Lughod: *Before*, op cit; p.267.
[481] K.N. Chaudhuri: *Trade and Civilisation in the Indian Ocean* (Cambridge University Press; Cambridge; 1985), p.98.
[482] Janet L. Abu-Lughod: *Before*, op cit; p.267.

Muslim traders in south India.[483] Calicut's attraction and reputation were enhanced by the fact that between 500 and 700 ships crammed its port area, and its city markets overflowed with rarest spices, aromatic products, pearls, and precious stones, which struck Portuguese imagination on their arrival in the late 15th century,[484] and soon after their envy and greed. It seems likely that the navigator who guided Vasco de Gama from Malindi, on the East African coast, to Calicut was a Gujarati.[485] The disastrous impact of such Portuguese irruption on the fate of Muslim trade in the region will be looked at in the final part of this work.

Africa, contrary to generalised views found in Western history, had a flourishing trade prior to the Western intrusion. When the Europeans entered West Africa from the coast, Wolf points out, they set foot in a country already dense with towns and settlements, and caught up in networks of exchanges that far transcended the narrow enclaves of the European emporia on the coast.[486] The textiles of Congo and Guinea, for instance, were as high in quality as those of Europe, and Nigerian decorated hides and leather were appreciated in Europe, reaching it via North Africa.[487] Muslim traders had visited the Red Sea on their route to the Mozambican coast, Ethiopia, and Zanzibar and South Africa, and as early as the 10th century, they had a colony in Madagascar. There was, of course, an intense caravan trade linking the North of Africa with the southern parts of the continent. And as Trimingham notes, Islam (the faith) has always followed trade routes.[488] Berber merchants (from north of the continent) had carried Islam across the Sahara into Sahilian states before the Murabit (Almoravid). All nomad people in the north east who found themselves about the trade routes that link the Red Sea with the Nile quickly became Muslim. Equally, the children of many Muslim traders who had married local women grew up associated with the culture of their mother, and it is from there that the Islamising of many villages began.[489] Also coming from Goa or Egypt, Islam penetrated as far as Chad, and met in Nigeria an old black civilisation, which was

[483] Ibid.
[484] W. Heyd: *Histoire*; Vol 2; op cit; p. 511.
[485] Gopal, 1975: 1; Tibbetts, 1981: p. 10; Abu Lughod notes that the rumour that it was the great Arab mu'allim (master sailor), Ahmad ibn Majid , author of a detailed if discursive 15th century navigational manual (see Tibbetts, 1981), who led the Portuguese to the Indian Ocean is patently impossible, since he was already a very old man in 1490 when his *Kitab al-Fawa'id*... was written in J.A. Lughod: *Before*; op cit; p. 272.
[486] E.R. Wolf: *Europe and the People Without History* (University of California Press; Berkeley; 1982), p. 40.
[487] R. Garaudy: *Comment l'Homme*, op cit; p.271.
[488] J. Spencer Trimingham: *The Influence of Islam Upon Africa*; op cit; p. 38.
[489] Ibid; p.42.

remarkable for its art, possibly tributary to Mediterranean classical influences, which it soon adopted.[490] In respect to trade itself, Islam legated to African society the concept of special consideration to traders and trading; and even more importantly, created a trading class. It imposed contractual laws, hence stimulating institutional as well as legal foundations, not just for trade, but for the whole of society, and, of course, it forbade the practice of usury.[491] It was the slave trade (16th century onwards) which would interrupt the progresses of the African continent, which Islam, before the Portuguese, had opened to change.[492]

Until this disastrous Western intrusion, some African parts, under the aegis of Islam, and acting as great trading centres, became during the high middle ages great centres of civilisation. Mali was one such place. As the remotest place on the gold road, Mali became famous in the Mediterranean world in the 14th century.[493] Its ruler, known as the Mansa Musa (r. 1312-37), reached legendary proportions. He was one of three Mansas to go on the hajj (proof of both power and stability of the Mali state, as the pilgrimage took over a year.) He travelled with 80 or 100 camels, each weighed down with 300 pounds of gold. It was the ritual magnificence and wealth of the court of Mali that impressed beholders. 'Everything about the Mansa exuded majesty.'[494] On his return from his pilgrimage to Makkah in 1324, Mansa Musa brought back with him the Muslim poet and architect, Es Saheli, who built the famous mosques and learning academies of Timbuktu and Gao.[495] Timbuktu, then, ranked with Alexandria, Fez, Seville, Cordova, and Constantinople as a great centre of learning.[496] The news of the Mansa's splendour reached Europe, and in Majorcan maps from the 1320s, and in the lavish Catalan Atlas of 1375, the ruler of Mali was portrayed like a Latin monarch, save only for his black face:

> 'Bearded, crowned and throned, with panoply of orb and sceptre, he is perceived and presented as a sophisticate not a savage: a sovereign equal in standing to any Christian prince.'[497]

[490] E. Perroy: *Le Moyen Age* (Presses Universitaires de France, 1956), p.525.
[491] J.S. Trimingham: *The Influence;* op cit; at p 38; and p.51.
[492] E Perroy: *Le Moyen Age*, op cit; p.525.
[493] Felipe. Fernandez-Armesto: *Before Columbus: Exploration and Colonisation from the Mediterranean to the Atlantic 1229-1492* (Mac Millan, 1987), pp. 146-7.
[494] Ibid.
[495] D. M. Traboulay: *Columbus and Las Casas,* (University Press of America, New York, 1994), p.70.
[496] G.O. Cox: *African Empires and Civilisations* (New York; 1974), p. 161.
[497] F.F. Armesto: *Before Columbus;* op cit; 146-7.

This resplendent impression ended in the mid 15th century, when direct contact with the outposts of Mali was briefly opened up by Portuguese penetration of the Gambia. Mali went into decline. Familiarity bred contempt and 'the heirs of the Mansa came to be seen as stage niggers- crude racial stereotypes dangling simian sexual organs.'[498] Further east of the continent, the same outcomes resulted from the Portuguese intrusion, when they arrived, their aim was to cut out Swahili middlemen and Muslim shippers. They established themselves at Sofala, the nearest port to Zimbabwe, in 1505, and later at Tete, a river port on the Zambezi.[499] Their presence was to have serious repercussions as to be outlined in the last part of this work.

b. Western Trade (The Mediterranean):

The predominant view amongst Western scholarship is that the Mediterranean trade went dead for centuries, and only reawakened in the 12th century following the arrival of the Normans, particularly after they wrested Sicily from the Muslims (1066-89). Thus, in the words of C.R. Beazley, one of the main 'authorities' on the subject, it took 'the spirit of an imperial race,' 'Northern Blood,' to awaken commercial and maritime activity in the Mediterranean.[500] A view espoused by scores more, a view, which, besides its blatant racial prejudice, is historically untenable. Contrary to such an opinion, Mediterranean trade was never dead, and the establishment of Islam entailed no curtailment of trading relations with the Christian West.[501] Ganshof remarks that the ports of Southern Provence had not stopped their activity from the 8th to the 10th century.[502] The Muslim arrival in the Mediterranean, Cahen holds, in fact, found trade links already dismantled by the barbarian invasions of the late 5th century, and a dying trade.[503] It was the Islamic arrival which brought such trade back to life. It is, as Lombard observes, the Muslims who revitalised exchange, just when

[498] Ibid.
[499] A. Pacey: *Technology in World Civilization* (The MIT Press, Cambridge, Massachusetts, 1990), Preface, p.71.
[500] C.R. Beazley: *The Dawn of Modern Geography*; 2 vols (London; 1897), vol 1; p. 130.
[501] R. Lopez quoted in G. Wiet et al: *History;* op cit; p.161.
[502] F.L. Ganshof, *Note sur les ports de Provence du viii au x siecle,* in *Revue Historique*, t. CLXXXIV, 1938, p. 28. The author suggests that the decline of the exchange economy could have other causes than the Muslim irruption, especially the state of anarchy where was sank the Franc monarchy after Dagobert.
[503] C. Cahen: *Commercial relations; op cit;* p.3.

Europe was 'exhausted', and so re-established and amplified international commerce.[504] Sabbe also notes how exchanges were both appreciable and continuous after the Muslim arrival.[505] Kramers, too, points out how since the 8th century Muslim travellers and traders were to be found in Italian towns and Constantinople.[506] In the 720s, for instance, St Willibad had found in Naples a ship in from Egypt.[507] Centuries later, in 1173, Benjamin of Tudela found in Montpellier (southern France) many foreign traders, particularly merchants from the Maghrib, Syria, alongside those from Lombardy, Rome, Genoa, Pisa, Egypt, Gaule, Spain, and England.[508] Muslims traded a considerable amount of goods, as will be seen gradually through this outline, carrying west, for instance, iron and steel products, porcelain and silk from China, spices from India, pearls from the Gulf, precious stones, perfumes, ivory, gold from all parts, and even food products in large quantities.[509]

The major reason behind the lack of appreciation of such exchanges between Islam and Mediterranean Europe is hostile historical interpretation, ideology interfering with the study of history of trade between Islam and Christendom as noted by Kreutz.[510] She points out, how the 19th century historian Matteo Camera, stirred by his patriotism and devotion to the Church, rid history of Amalfi's trading exchanges with Islam,[511] contacts which were deemed disgraceful by Beazley, in whose words, Venice, unlike Amalfi, was not 'stained by disgraceful alliance with the Moslems to the damage of Christian lands.'[512] Yet, Muslim Spanish products, for instance, especially of the refined sort, found great place even amongst the higher echelons of Christian society. Thus, the Book of Papa 'Liber Pontificalis' cites fourteen pieces of Spanish textile with silver work.[513] And in the biographies of Pope Gregory IV (Pope 827-844) and of Leo IV (Pope

[504] M. Lombard: l' Or Musulman au Moyen Age, in *Annales ESC* (1947); pp.143-60.
[505] E. Sabbe: l'Exportation des tissus orientaux en Europe occidentale au haut Moyen Age, in *Revue Belge de philologie et d'histoire* XIV (1935); 811-48 and 1261-88.
[506] J. H. Kramers: *Islamic Geography and Commerce;* reprinted in *The Islamic World and the West;* Edited by A.R. Lewis (John Wiley and Sons, Inc, London; 1970), pp. 66-78. at p. 76.
[507] Willibald Hodoeporicon S. Willibaldi: *Itinera hierosolymitana et descriptones Terrae Sanctae*; Ed. T. Tobler and A. Molinier; 1879; reprint (Omasbruck 1966), p. 256.
[508] Itinerar. Terrae Santae." *Bibl. de l'Ecole de chartes*, 2nd series, Vol III, p. 203.
[509] G. Wiet et al: *History;* op cit, at p.163.
[510] B.M. Kreutz: *Before the Normans* (University of Pennsylvania Press; Philadelphia; 1991), p.79.
[511] Matteo Camera: *Memorie storico-diplomatiche dell'antica citta e ducato di Amalfi;* 2 vols; (1876).
[512] C.R. Beazley: *Dawn;* op cit; vol 1; p. 170.
[513] In S. Imamuddin: *Muslim;* op cit; p. 112.

847-855) Spanish textiles are cited along with those of Byzantium,[514] whilst an English historian writing on the 12th century marriage of Philip of Flanders with Beatrix of Portugal at the end of the 12th century, also makes the eulogy of Spanish Muslim made stuffs.[515]

The port of Alexandria was a principal link in the East-West exchange network, and its activities highlight the fact that trade never ceased in the Mediterranean during the medieval Islamic period. One witness, the Christian pilgrim Arculf (late 7th century), who, passing through Alexandria, thirty years after the Muslims took the city, met innumerable races' taking on provisions.[516] Just as in Antiquity, medieval Alexandria remained the place from where goods from the Orient reached the West; the main emporium, the '*forum publicum utrique orbi*,' as William Tyre called it.[517] During the 11th-12th centuries, Egypt's chief indigenous export was flax and linen, commodities eagerly sought by European and North African merchants who frequented the markets of Cairo and Alexandria.[518] According to al-Idrisi (1100-65), the main articles of trade were musk, pepper, cardamom, cinnamon, galingale (khalanj), myrobalan, camphor, coconut, nutmeg, aloe, ebony, shells, ivory, china, all of which came from Asia, plus incense, myrrh, balsams, and benzoin brought from the Hadramut, Somaliland, or the Sudan; spices, especially pepper (one of the gates of Alexandria was called the pepper-gate.)[519]

Muslim Spain was also a powerful relay between East and West, as Constable in her excellent work on the country's trade shows. Al-Andalus was a major channel through which eastern spices, precious metals, textiles, paper, and other items flowed into Europe, and prior to the European awakening in the central middle ages, Andalusian markets supplied many of the 'the good things' in Western Christian life.[520] Andalusians could be seen everywhere in the Arab East and North Africa, as well as in the Mediterranean, in places such as Majorca, Minorca, Sardinia, Sicily, Crete and others, in their capacities as colonizers, students, teachers, merchants, pilgrims, missionaries, civil servants, skilled workers and artisans.[521] Their

[514] G. Migeon: Arts Plastiques et industriels; ii; p. 320; in S.M. Imamuddin: *Muslim*; op cit; p. 112.
[515] G. Migeon: Arts; p. 320; in S.M. Imamuddin: *Muslim*; op cit; p. 113.
[516] G. Wiet: *History*; op cit; p.161.
[517] G. Sarton: *Introduction;* Volume III; p.229.
[518] A.L. Udovitch: Trade: op cit; 107-8.
[519] Kammerer pp. 10-14, 1929; in G. Sarton: *Introduction*; Volume III. p.229.
[520] O.R. Constable: *Trade and Traders*; op cit; p.2
[521] A. Chejne: The role of al-Andalus in the movement of ideas between Islam and the West: in *Islam and the Medieval West*; K. I. Semaan; ed: op cit; pp 110-33; p.114.

commercial activities took them, besides the various Islamic countries, to Greece, Italy, France, and also Northern Europe, where they traded all sorts of goods.[522] In Muslim countries, evidence of their presence can be seen nowadays in Morocco, Algeria, and Tunisia, not only in the arts and architecture of these countries, but in the names of villages and family names.[523]

Most of the Muslim exchanges with the non Muslim Mediterranean world were with the Italians. Throughout the 9th century, Kreutz notes, in cultural splendour and affluence, the Islamic Mediterranean world vied with, and in some respects surpassed Byzantium, and despite the Muslim raids, over time the south Italian relationship with the Islamic sphere brought increased prosperity, at least to much of Campania.[524] It seems likely that, in the 10th century, many regional churches were embellished with artefacts brought from the Muslim world even if documented references begin only in the early 11th century and then primarily mention 'Spanish' or 'Moorish' textiles.[525] The Muslim historian, Ibn Hayyan (d. 1076), mentions a treaty for peace and commercial security negotiated between the Umayyads and the Counts of Barcelona in 939, and described a visit to Cordoba by Amalfitan merchants in 942.[526] Ibn Hayyan went on to say that, after this successful Amalfitan visit, 'their successors,' continued to come to al-Andalus and make great profits.[527] Registers from the second half of the 12th century contain roughly fifty contracts for Genoese voyages to Andalusi ports or for sales of Andalusi goods.[528] In 1160, for instance, a Genoese merchant agreed to transport Andalusi textiles from Genoa to Bejaia in Algeria, while another promised to carry goods from Genoa to Bejaia, Oran, Ceuta or Yspania in 1197.[529]

War, and even the crusades (1095-1291), hardly impeded the large presence of Italian traders in the far western lands of Islam (that is North Africa) as well documented by De Mas Latrie.[530] The Pisans, Florentines, Genoese, Venetians, Sicilians had trade establishments in the Maghrib; Christian funduqs (storage and trading establishments as well as hostels for traders)

[522] Ibid.
[523] Ibid.
[524] B.M. Kreutz: *Before the Normans*; op cit; p.18.
[525] Ibid; p. 142.
[526] O.R. Constable: *Trade and Traders;* op cit; p. 97.
[527] Ibn Hayyan: *Kitab al-Muqtabis fi tarikh al-Andalus*; v; ed by P. Chalmeta et al (Madrid-Rabat; 1979), pp. 478-85.
[528] O.R. Constable: *Trade and Traders;* op cit; pp. 42-3.
[529] Giovanni Scriba: *Il Cartolare di Giovanni Scribba*; eds M. Chiaudano and M. Moresco (Roma; 1935), ii; p. 4; # 812.
[530] M.L. de Mas Latrie: *Traites de Paix*; op cit.

principally located in Tunis, El-Mehdia, Tripoli, Bone, Bejaia, Ceuta, and Oran; the Pisans and Genoese disposing of further establishments in Gabes, Sfax, and Sale.[531] The Funduqs gradually became places where the merchants sold their goods, and every funduq became 'a part of Europe'.[532] In Tunis, Bejaia, El-Mehdia and other places, the Venetians had changing offices, public writers, and shops where they sold goods as in the Place of St Mark.[533] In Tunisia, the Pisans were seen as old friends, and had a special Funduq, comprising many houses, where they worked in all security, the regard paid to them is obvious in a letter sent by one emir to the Archbishop of Pisa, chief of the government of the republic.[534] The Florentines, too, used Tunis warehouses and benefited from guarantees granted to their nation.[535] The Genoese were also well established in Bejaia (modern Algeria), reselling products they had imported, such as cotton, linen and indigo, whilst Bejaia exported to Genoa products which she also imported such as alum, wax and gold.[536] Genoa, Pisa, and Venice also had good trading links with Morocco; Genoa, most particularly, disposing of privileged links and establishments in the country.[537] Sicilians and Sardinians, too, without neglecting Morocco, were, like the Genoese and the Pisans, in continuous business rapport and interest with Tunis and Oriental 'Mauritania' (eastern Algeria). Also active under patronage of the pavilions of the great maritime cities, were the smaller ports in Liguria and Dalmatia, and the rich merchants of Tuscany and Lombardy.[538] By the rule of Abu Zakaria (1228-), the main Christian nations owned permanent establishments in Africa, entertaining councils and envoys to safeguard their interests and manage their businesses.[539]

The relationships with the Italian cities were codified in a number of documents. De Mas Latrie refers to Amari's piecing together 84 original documents, the oldest dating from 1150, including 41 pieces all related to the Maghrib, many in duplicate and original contemporary text;[540] the best collection concerning the relations between Christians with North West Africa in the Middle Ages.[541] Such treaties between the Muslims and the Italian republics guaranteed the security of the merchants, including the

[531] Ibid; pp.88-92.
[532] B. Rosenberger: La Pratique; op cit; pp. 271-2.
[533] M.L. de Mas Latrie: *Traites de Paix*; op cit; p.89.
[534] Ibid; p.37.
[535] Ibid; p.251.
[536] C. Singer: *The Earliest Chemical Industries* (The Folio Society; London; 1958), p.82.
[537] M.L. de Mas Latrie: *Traites de Paix*; op cit; p. 64; p.37.
[538] Ibid; pp. 84; and pp. 88-92.
[539] Ibid; p. .84.
[540] M. Amari: *I Diplomi arabi del reale archivio Fiorentino* (Florence, Lemonnier, 1863).
[541] M.L. de Mas Latrie: *Traites de Paix;* op cit; p.xv.

possibility of legal recourse, and stipulating precisely the conditions of trade.[542] These treaties had the merit of improving the status of merchants, who with time obtained the right of interpreters, recognition by consular authorities, and wide autonomy of action.[543]

The same intense trading activities also prevailed within the Muslim Mediterranean realm itself, as briefly outlined here. This inter-Muslim trade brought together vast expanses of land in exchanges. There is evidence from Muslim sources, Singer points out, that alum was reaching Bejaia, on the Mediterranean coast, and the North African posts by caravan across the Sahara, which illustrates the excessive intricacy of early trade relationships in the Mediterranean.[544] Glick insists that the purchasing power exercised by al-Andalus in virtue of its high standard of living in comparison with the Islamic East was enormous, and the Andalusi played a significant role in Muslim Mediterranean trade.[545] Levi Provencal[546] and Imamuddin[547] have provided excellent data on such trade within Andalusia, in both ordinary and luxury goods; heavily loaded convoys criss-crossing the country between major towns and cities and to export harbours.[548] Glick, too, explains the economic closeness between Muslim Spain and North Africa: in Morocco, for instance, Andalusi merchants were selling their own finished cloth (Valencian brocade, according to al-Shaqundî), as well as copper, a staple export.[549] Under the united rule of the Almoravids and Almohads (1088-1248) who united Spain with the Maghrib, the great Moroccan cities, Marrakech and Fes, especially, became extensions of the Andalusi urban economy, merchants moving back and forth freely, bearing Spanish goods on camelback.[550] Until the early 11th century, Andalusi commerce with the East was carried through Tunisian towns,

[542] B. Rosenberger: La Pratique; op cit; p. 271.
[543] Ibid; pp. 271-2.
[544] C. Singer: *The Earliest Chemical Industries*; op cit; p.82.
[545] T. Glick: *Islamic and Christian Spain;* op cit; p. 130.
[546] Other than works by Levi Provencal already referred to, see by the same author:
L. Provencal: *Documents arabes inedits sur la vie sociale et economique en Occident Musulman au Moyen Age* (Cairo; 1955).
[547] S.M. Imamuddin:
-Commercial relations between Muslim Spain and Christian countries in the 9th and 10th centuries; *Journal of Asiatic Society of Pakistan*; Vol 3; 1958; pp 1-13.
-Commercial relations of Spain with Ifriqiyah and Egypt in the 10th century; *Islamic Culture*; Vol 38 (1964), pp 9-14.
-*The Economic History of Spain Under the Ummayads* (711-1031) (Dacca; 1963).
[548] E. Levi Provencal: *Histoire*; op cit; p.317.
[549] Al-Shaqundi in T. Glick: *Islamic and Christian;* op cit; pp.130-1.
[550] T. Glick: *Islamic and Christian Spain*; pp.131.

with al-Qayrawan and its port, al-Mehdia, playing the crucial role.[551] Andalusi merchants stationed in Tunisia were receiving Egyptian or Syrian goods there and selling them on the spot or, if the home market was judged more favourable, shipping them on to Spain.[552]

The Muslim loss of Spain (13th century) (except for the Grenada enclave, which was to fall in 1492), the crippling of the North African trade and coastal economies by recurrent pirate attacks and raids, and the destruction of the Syrian economy by a succession of invaders, crusaders (11th-13th), Mongols (13th), and subsequently Timur (early 15th), which will all be examined in detail in the last part of this work, meant that from the 13th onwards, Egypt remained the main Muslim trading centre on the Mediterranean. Egypt remained until the 16th century the transit market for Eastern spices and other Oriental products; silk from Spain and Sicily, textiles from various points around the Mediterranean, olive oil from Tunisia, and metals (iron, copper, lead, tin, and mercury) from Spain and other European countries.[553] Metals and, understandably, wood, figured very prominently in Egyptian imports.[554] In the 16th century, however, Mamluk Egypt was ruined by the Portuguese irruption and piracy in the Indian Ocean.[555] This, as the last part will amply show, meant the death of Islamic trade, and not just in the Mediterranean.

[551] Ibid.
[552] Ibid.
[553] A.L. Udovitch: Trade; op cit; pp.107-8.
[554] Ibid.
[555] See for instance: W. Heyd: *Histoire*; op cit; I Lapidus: *Muslim Cities*; op cit.
-S.M. Imamuddin: Maritime Trade under the Mamluks of Egypt (1250-1517); *Hamdard Islamicus*; vol 3; no 4 (1980).
-W.J. Fischel: "The Spice Trade in Mamluk Egypt: A Contribution to the Economic History of Medieval Islam," in *Journal of the Economic and Social History of the Orient*, 1 (1958).
-Al Makrizi (al-Maqrizi): *Histoire des sultans Mamlouks de l'Egypte*, Etienne M. Quatremere, trans., 2 vols. (1837-1845).
-Al-Makrizi: *Les Marches du Caire*: Traduction annotee du texte de Makrizi, Andre Raymond and Gaston Wiet, trans (1979).
For other factors affecting Mamluk trade and prosperity (i.e the plague) see R. Lopez; H. Miskimin and A. Udovitch: England to Egypt, 1350-1500:Long term Trends and Long Distance Trade, in M.A. Cook Ed: *Studies*; op cit; pp. 93-128.

Two

CITIES OF ISLAM

When during the crusades (1095-1291), the Western Christians came in contact with the Muslim East, Erbstosser says, the size and structure of Muslim cities must have been impressive for such crusaders.[556] At the beginning of the 11th century, Tripoli in today's Syria, had 80,000 inhabitants and its fortifications enclosed an area of about 12,000 hectares. Not only did it possess a series of palaces, but its five and six storey buildings were also an impressive sight.[557] The city also had centralised water supply systems, which were either in the form of cisterns with pipes leading to the houses of the wealthy citizens at least, or, in individual cases, consisting of an integrated mains supply system for the entire city.[558] The same can be said for other cities, where also street lighting had been common in their centres since the 10th century, vegetable oil being used as fuel in Syria, for example.[559] Public baths, with strict male and female segregation and sometimes of considerable artistic merit, were just as familiar a part of the urban scene as the great hospitals, libraries and schools.[560] The streets of Muslim cities were also paved, and many were actual mosaics of different coloured stones, often shaded with canopies stretching between the roofs of the buildings to give shelter from sun and rain.[561]

It was, thus, a new and alien world with advanced economic and cultural standards, that confronted the crusaders.[562] Indeed, the contrast between

[556] M. Erbstosser: *The Crusades* (David and Charles; Newton Abbot; Leipzig; 1978), pp. 130-1.
[557] Ibid.
[558] Ibid.
[559] Ibid.
[560] Ibid.
[561] Z. Oldenbourg: *The Crusades*; tr from the French by A. Carter (Weinfeld and Nicolson; London; 1965), pp. 476; 498.
[562] M. Erbstosser: *The Crusades;* op cit; pp. 130-1.

East and West as far as urbanisation goes could not be sharper. In medieval times, whilst Western Christendom was formed of a society primarily agrarian, feudal, and monastic, the strength of Islam was in its great cities, wealthy courts, and long lines of communication.[563] In Europe, the cities of antiquity had disappeared due to economic crises, (5th century) invasions and brigandage; the town was now merely a cramped *castrum* for defence and refuge; the period was marked by the triumph of the large estate and of rural economy 'Barbarisation and ruralisation having spread over almost the whole of the Western World,' says Lombard.[564] Which contrasts sharply with Islamic Cordova, a city of fountains; baths, schools, and much else, its thoroughfares, for a distance of miles, brilliantly illuminated, substantially paved, kept in excellent repair, regularly patrolled by guardians of the peace.[565] In Paris there were no pavements until the 13th century; in London none until the 14th; the streets of both capitals were often impassable, and it was only at the close of the reign of Charles II (17th century), that even a defective system of street lighting was adopted in London.[566] And the contrast was even greater, when considering that a city such as Baghdad at the end of the 9th century had a population exceeding one million people, whilst even in the 13th century, Lombard insists, we are struck by the difference with Western Christendom; cities in Italy, or Flanders, with population not exceeding thirty or forty thousand people.[567] In 1700, London, the most populous city of the Christian West, was only half as large as Cordova was in 900, when Almeria and Seville had 'each as numerous a population as the capital of the British Empire eight hundred years afterwards.'[568] It was only in the 14th century that Paris, the largest city in the Christian West, reached three hundred thousand inhabitants.[569]

It is not just this contrast which is startling, especially when one considers today's situation, it is more astounding that the early environment of Islam was the sands and tents of Arabia. Most remarkable of all, though, is the fact that, whilst Western medieval contemporaries, as just noted, were amazed at the superiority of the Islamic urban setting, just as the medieval

[563] R.W. Southern: *Western Views of Islam in the Middle Ages* (Harvard University Press, 1978), p. 7.
[564] M. Lombard: *The Golden;* op cit; p. 119.
[565] S.P. Scott: *History;* Vol 3; op cit; pp 520-2.
[566] Ibid.
[567] M. Lombard: l'Evolution Urbaine; pendant le Haut Moyen Age; in *Annales,* vol 2 (1957) pp. 7-28; p. 24.
[568] S.P. Scott: *History; op cit;* pp 520-2.
[569] M. Lombard: l'Evolution Urbaine; op cit; p. 24.

Western scholars were amazed at Islamic learning, modern Western 'scholars,' in general, in their comments and writing on Muslim cities, turn everything upside down, and instead, deride the whole Islamic history of urbanism. This is one of the points of focus in this chapter. Other points will deal with the remarkable integration of early Islamic cities, including facilities and services, which surely anticipated those prevalent in modern cities of the advanced world today, and a management of urban services which today's Islamic cities will be at great pain to match.

1. The Islamic Urban Setting: Countering Western Fallacies:

Lombard notes that Sao Paulo in Brazil, said to be the fastest growing city in the world (its population rising from 60,000 in 1888 to 2 million in 1950), hardly, in fact, compares with the growth of Baghdad from 500 inhabitants in 762 to nearly 2 million in 800.[570] This was by no means an isolated case. Some of the greatest cities of the Middle Ages anywhere were all founded in early Islam, cities such as Cairo, Al-Qayrawan and El-Mehdia in Tunisia; Fes and Marrakech in Morocco; and Al-Kufa and Basra in Iraq.[571] The latter two grew exceptionally rapidly, from just small towns, into great cities, Kufa reaching 100,000 inhabitants, and Basra 200,000 in the space of three decades.[572] Samarra's population according to Herzfeld might have reached 1 million in the 9th century.[573] Fustat's medieval population must have risen to between 450,000 and 600,000.[574] And the same in Spain, where sudden and fast rises turned once sleepy towns into large cities, Al-Maqqari (d.1632) refers to an anonymous medieval author who states that in Spain there were 80 cities of the first rank, 300 of the second, and so many smaller towns and villages that only God could count them.[575] At their heights, Seville contained 500,000

[570] Ibid; p. 118.
[571] A.L. Udovitch: Urbanism; in *The Dictionary of the Middle Ages*; op cit; Vol 12; pp 306-10.
[572] M. Lombard: *The Golden;* op cit; p. 123.
[573] E.E. Herzfeld: *Geschichte der Stadt Samarra* (Hamburg; 1948), p. 137.
[574] M. Clerget: *Le Caire* (Cairo 1934), pp. 126; 238-9;
J. Abu Lughod: *Cairo* (Princeton; 1971), p. 37.
[575] Al-Maqqari: *Nafh Al-Tib.* Translated by P.De Gayangos: *The History of the Mohammedan Dynasties in Spain* (extracted from *Nifh Al-Tib* by al-Maqqari); 2 vols (The Oriental Translation Fund; London, 1840-3), Vol 1; p. 87.

inhabitants; Almeria an equal number; Granada 425,000; Malaga 300,000; Valencia 250,000; Toledo 200,000.[576] Under the Muslims, Cordoba became one of the most important and most populous cities of the Mediterranean.[577] Its population has been variously estimated at between 100, 000 and one million, but the latter figure is more plausible as archaelogical works in the city have revealed its huge medieval size, which fits with the one million figure.[578] After the construction of two new cities, Madinat al-Zahra (940-941) and Madinat al-Zahira (978), it became in the 10th century a conurbation of more than 15 kilometres.[579]

Cities played a fundamental part in the history of Islam, which is somehow paradoxical when remembering that those who carried the faith throughout the world, from the Himalayas to the Pyrenees, were mainly Arabs and Bedouins 'who never slept between four walls,' says Marcais.[580] A point also noted by Udovitch, who contrasts the desert and oases 'the setting of its birth,' with the cities and towns 'the setting of Islam's growth and maturity.'[581] From Makkah and Madinah, the centres of power, culture, and wealth moved to such urban sites as Damascus, Baghdad, and Samarkand, and to Cairo, Qayrawan, Fes, and Cordoba.[582] And Islam, again, stands central to this urban process. 'To achieve its full social and religious ideal, Islam cannot do without urban life,' explains Marcais, who also highlights how, the mosque, central element of the faith, both in religious and political terms, supposes both permanence and urbanity; and so 'The mosque creates the Islamic city.'[583] Something obvious not just in the East, but also in the West, the centrality of the mosque in a vast urban setting was obvious in Seville, Valencia and other Muslim Spanish towns.[584] Further contributions of the faith to this urban rise will be seen as the outline proceeds.

[576] S.P. Scott: *History;* op cit; vol 1; pp 613-4.
[577] M. Acien Almansa and A. Vallejo Triano: Cordoue, In *Grandes Villes Mediterraneenes du Monde Musulman Medieval;* J.C. Garcin editor (Ecole Francaise de Rome; 2000), pp .117-34; p. 117.
[578] A.M. Watson: A Medieval Green Revolution; New Crops and Farming Techniques in The Early Islamic World, in *The Islamic Middle East 700-1900;* edited by A. Udovitch (Princeton; 1981), pp. 29-58; note 45; p. 57.
[579] M. Acien Alamnsa and A. Vallejo Triano: Cordoue; op cit; p. 117.
[580] G. Marcais: l'Urbanisme Musulman, in *Melanges d'Histoire et d'Archeologie de l'Occident Musulman*; Vol 1; Gouvernement General de l'Algerie; Alger; 1957; pp 219-31; at p. 219.
[581] A.L. Udovitch: Urbanism; op cit.
[582] Ibid.
[583] G. Marcais: l'Urbanisme; op cit; p. 219.
[584] T. Glick: *Islamic and Christian*; op cit; p. 114.

Even when acknowledging the urban character of Islamic civilisation, mainstream Western historians and commentators wrote very disparagingly on Islamic cities, writing, which is, however, wholly contradicted by historical reality. Three main strands of attacks on Islamic cities, and their refutation, are dealt with here.

The first attack on Islamic cities is that they were not cities in the modern sense. Max Weber, in the late 19th century, for instance, suggested that there were five distinguishing marks of the medieval city: fortification; markets; a legal and administrative system; distinctive urban forms of association, and partial autonomy.[585] Since the Muslim city lacked some of these marks, Weber maintained, they were not cities, just chaotic concentrations of crowds.[586]

Weber's, like others', derogatory approach to the Islamic city is not unique. Each and every aspect of Islamic civilisation, sciences, history and faith, has been identified and defined from a derogatory angle. This work will show this recurrently. A few instances are looked at here, briefly, to illustrate this, before refuting Weber and his hordes of followers. Muslim universities are thus said not be universities, because they lacked a definite date and legal status in their foundation.[587] Which is odd considering that neither were subsequent European universities, which were also based in every respect (organisation, administration, campus system, certificates, learning…) on Muslim antecedents.[588] The same is also said about Muslim chemistry, defined as an occult practice called alchemy, which is also odd when Western chemistry inherited everything (classification of metals, the use of experimentation, the vocabulary, the laboratory etc,) from its Islamic predecessor.[589] And the same with respect to the observatory in Islam, which is deemed not an observatory, when every single feature found in the Muslim observatory (use of large instruments, gathering of large number of scientists, prolonged observation, etc,) was to be found in its successor the Western

[585] M. Weber: *The City*; D. Marindale and G. Newirth tr. (Glenco; 1958).
[586] in N. AlSayyad: *Cities and Caliphs* (Greenwood Press; London; 1991), p. 34.
[587] H. Rashdall: The Universities of Europe in *The Middle Ages*, ed F.M Powicke and A.G. Emden, 3 Vols (Oxford University Press, 1936).
[588] J. Ribera: *Dissertaciones y opusculos*, 2 vols (Madrid, 1928).
George Makdisi: *The Rise of Humanism in Classical Islam and the Christian West* (Edinburgh University Press, 1990).
[589] E.J. Holmyard: *Makers of Chemistry* (Oxford at the Clarendon Press, 1931).

observatory.[590] And the same is said and written with respect to hospitals, described as mere 'maristans.' Muslim civilisation, itself, is said to be a plagiarised form of Greek civilisation, whilst the faith of Islam, said to be a mere corruption of other faiths.[591] Even the military victories of Muslim armies, including that of Ain Jalut in 1260 which broke the deadly Mongol onslaught on Islam, was painted as a pale success against a handful of Mongols,[592] or was only a skirmish says Saunders,[593] who oddly enough also says that it was a turning point in history, and that the Mamluk victory at Ain Jalut saved Islam.[594] Hence, Weber's derogatory attitude to Islamic cities is neither new, nor unique. Nor can it stand up to scrutiny, as shown by the following.

In contrast to the ancient city or to the Western communes of the later Middle Ages, Islamic cities possessed no special legal or corporate status. The town as such is not recognized in Islamic law notes Udovitch.[595] Nor can we identify any institutions for internal governance, such as guilds or municipal councils, which have been used by social historians to deny the title of city to the Islamic city. But as Goitein points out, "the medieval Islamic city was a place where one lived, not a corporation to which one belonged."[596] The 'ulama', or religious scholars, Udovitch notes, 'served as a cohesive force within the urban amalgam,' just as did the muhtasib (the state inspector of corporations, trades, and markets) and a number of formal and informal groupings, including the extended families, the neighbourhoods, local constabulary, and religious orders. The Islamic cities represented effective social realities, and as seats of the government or its representatives they guaranteed security; as local markets or

[590] L. Sedillot: Memoire sur les instruments astronomique des Arabes, *Memoires de l'Academie Royale des Inscriptions et Belles Lettres de l'Institut de France* 1: 1-229 (Reprinted Frankfurt, 1985).
A. Sayili: *The Observatory in Islam* (Turkish Historical Society, Ankara, 1960).
[591] Such as found in literally every work on Islam, such as:
-C. Brockelmann: *History of the Islamic Peoples*; tr. from German (Routledge and Kegan Paul; London; 1950 reprint).
[592] G. Guzman: Christian Europe and Mongol Asia: First Medieval Intercultural Contact Between East and West; *Essays in Medieval Studies*, Volume 2; pp. 227- 44; at p. 233.
[593] J.J. Saunders: *The History of the Mongol Conquests* (Routlege & Kegan Paul; London; 1971), p. 117.
[594] J.J. Saunders: *Aspects of the Crusades*; University of Canterbury (Canterbury; 1962), pp.67; and p. 64. See also C. Hillenbrand: *The Crusades, Islamic Perspectives* (Edinburgh University Press; 1999), the latter's depictions of Islamic military successes, as in p 574 fwd, always accomplished against a weakened foe; often victories and successes only fruit of Islamic folk epic and imagination.
[595] A.L. Udovitch: Urbanism; op cit; p. 310.
[596] D. Goitein: A Mediterranean Society in A.L. Udovitch: Urbanism; pp. 310-1.

international emporiums they provided economic opportunities; and with 'their mosques and madrasas, their churches, synagogues, and schools, their bathhouses and other amenities, they contained all that was needed for leading a religious and cultured life.'[597] Oldenbourg also notes how in large cities there were schools for all, free for young children and sometimes even for university students; there were public baths at every street corner, as well as many private pools.[598] Oldenbourg also points out that Muslim cities, cosmopolitan by nature, were great centres of commerce, into which caravans flowed from all corners of the East and the West.[599] They were administrative centres employing thousands of clerks, cultural centres where sometimes tens of thousands of manuscripts were preserved in public and private libraries, where schools of literature and philosophy of all persuasions met, where men assembled in public squares to discuss the Qur'an; each of these cities a world in miniature; even the small cities, like Homs and Shaizar, had 'an opulence and comfort which European kings might have envied.'[600] Islamic cities thus met the requirements of the modern city we have today, and were centuries ahead of their Western counterparts in doing so.

The second form of attack against Islamic cities is their 'chaotic' nature, the chaos seen as a child of Islam, the faith. Thus, Planhol says:

> 'Irregularity and anarchy seem to be the most striking qualities of Islamic cities. The effect of Islam is essentially negative. It substitutes for a solid unified collectivity, a shifting and inorganic assemblage of districts; it walls off and divides up the face of the city. By a truly remarkable paradox this religion that inculcates an ideal of city life leads directly to a negation of urban order.'[601]

This is part of a wider line of attack on Islamic cities as outlined by AlSayyad:

> 'Housing is mainly made up of inward oriented core residential quarters, each allocated to a particular group of residents and each is served by a single dead end street. As for its spatial structure, the Muslim city has no large open public spaces and the spaces serving its movement and traffic network are narrow, irregular

[597] A.L. Udovitch: Urbanism; pp. 310-1.
[598] Z. Oldenbourg: *The Crusades*; pp. 497-8.
[599] Ibid; p. 498.
[600] Ibid.
[601] Xavier de Planhol: World of Islam (Ithaca; Cornell University Press; 1959), p. 23. in N.AlSayyad: *Cities*; op cit p. 23.

> and disorganised paths that do not seem to represent any specific spatial conception.'[602]

The anarchy attributed to the Islamic model is refuted by historical evidence, though. Jairazbhoy, for instance, argues:

> 'First of all irregularity has always been alien to Islamic art, and indeed in architectural designs there is usually an over zealous desire for symmetry. The irregularities of streets in Muslim towns are the result of subsequent haphazard growth.... It is people who are at fault, not the system.'[603]

The image conveyed in Western scholarship of Islam as a faith being the source of anarchy and asymmetry is, indeed, fundamentally contradicted by the faith. Gazing at designs on a Muslim prayer carpet, whether these designs are of Makkah, or a mosque interior, or any other motif, will show absolute, perfect symmetry and precision. Anything on the left side of the carpet is found on the other as if computer designed. No Islamic carpet will show asymmetry. Prayer itself, in a mosque (or anywhere else), is perfect order, in the reading of the verses, in the timing of the prayers, in the direction of the prayers, in the numbers of the (rakaas) (prostrations); in the line of worshippers, in the simultaneity and harmony of their prostration etc. The Qur'an is recited with absolute, perfect orderliness, in form, in sound, in the repetitions, in the length of the verses, etc.. Exactitude and utmost precision are constantly expected of the faithful in every deed, in making contracts, in inheritance matters, in the way of fasting, in distributing alms, in the way of performing pilgrimage etc. The gardens of Islam are absolute perfect symmetry and order; and so is the art of Islam, as the consultation of any book on Islamic art will show, and so on. It is secular, Western inspired, Islamic society, which is messy. Such 'modern' society simply has no parameter upon which to build order. Neither has it any parameter of any sort that helps it build or respect green spaces, or look adequately after its water supply, or clean its streets etc. The chaos of modern Islamic cities today is, indeed, undeniable, but, rather than being the outcome of Islam, it is the result of the secular elites in power, and their ineptness in imitating Western models, whilst they have only contempt for anything Islamic.

Historically speaking, Al-Sayyad demonstrates that the irregularity of forms in Muslim cities as a response to social and legal codes and as a representation of the Islamic cultural system had no foundation. Muslim

[602] N.AlSayyad: *Cities*; p. 6.
[603] R. Jairazbhoy: *Art and Cities of Islam* (New York Asia Publishing House; 1965), pp 59-60, in AlSayyad p. 23.

towns were originally designed according to very regular geometric patterns, and they only achieved an irregular form in later years probably due to many factors.[604] In this respect, the outline by Lassner on the foundation of Samarra (today's Iraq) in the 9th century is an excellent illustration of how fundamentally Islamic urban design stands wholly at the opposite end of what stereotypes claim. Samarra, the second great capital of the Abbasid caliphate, was situated along the Tigris some sixty miles (ninety-seven kilometres) north of Baghdad. The city was subject to meticulous planning; several thoroughfares running almost the entire length and breadth of the city.[605] The main thoroughfare was the "Great Road" (*shari' al-a'zam*), called al-Sarjah, extended the entire length of the city. With later extensions it ran some 20 miles (32 kilometres) and was reported to have been 300 feet (91 meters) wide at one point. The part of the road that still exists, although somewhat narrower (240 feet or 73 meters), testifies, indeed, to dimensions that were staggering. The great government buildings, the Friday mosque and the city markets were all situated along al-Sarjah; and it was throughout the entire history of the city the main line from which most of the city's traffic radiated toward the Tigris and inland.[606] The market areas were subsequently enlarged and the port facilities expanded as part of an energetic program that included the refurbishing and strengthening of already existing structures.[607] The new mosque was an enormous structure; and as it was to serve the entire population of Samarra (which resided for the most part along the first two thoroughfares inland), three major traffic areas had to be constructed along the width of the urban area. Each artery was reported to have been about 150 feet (46 meters) wide so as to handle the enormous traffic; each artery flanked by rows of shops, representing all sorts of commercial and artisanal establishments; the arteries in turn connected to ample side streets containing the residences of the general populace. The Great thoroughfare was extended from the outer limits of Samarra, and feeder channels that brought drinking water flanked both sides of the road.[608] And Samarra was not alone. Sketches of all the cities founded under Islam (Fes, Al-Qayrawan, Cairo…) equally had wide roads and spaces, green spaces, and perfect geometry and symmetry were fundamental to their design.

[604] AlSayyad: *Cities*; p. 154.
[605] J. Lassner: Samarra; *Dictionary of Middle Ages;* op cit; vol 10;pp. 642-3.
[606] Ibid.
[607] Ibid.
[608] Ibid; pp. 643.

In fact, still in relation to urban chaos and anarchy, if a brief comparative exercise between Islamic and Western cities during the medieval period (and even up to the recent times) is made, it will further confirm how, in general, Western writing is the very opposite of historical reality. Islamic cities, first, like large Islamic towns, were paved with stones, and were cleaned, policed, and illuminated at night, whilst water was brought to the public squares and to many of the houses by conduits.[609] The houses were large buildings, several storeys high, housing numerous families, with terraces on the roofs, internal galleries and balconies, and fountains in the centre of the courtyards.[610] 10th century Cordova is said to have had 200,000 houses, 600 mosques, and 900 public baths, and its thoroughfares, for a distance of miles, were brilliantly illuminated, substantially paved, kept in excellent repair, regularly patrolled by guardians of the peace.[611] Living conditions in 16th century Algiers, according to Western contemporary visitors:

> 'Compared favourably with those in northern capitals. The domestic architecture, the flowered patios and gardens of the race which built the Alhambra were among the most attractive in the world. Every respectable house had a galleried courtyard and a flat roof embellished with potted plants. An efficient water supply provided numerous fountains and cleaned the streets to a degree unknown in England.'[612]

And long would be the list of early Islamic cities which could boast huge expanses of gardens.[613] Every city had its countless gardens, and on the outskirts were great orchards full of orange and lemon trees, apples, pomegranates, and cherries.[614] In North Africa, one learns of a multitude of gardens, surrounding and inside cities such as Tunis, Algiers, Tlemcen, and Marrakech.[615] In the city of Samarra, a garden of the 9th century consisted of 432 acres, 172 of which being gardens with pavilions, halls and basins.[616] In Turkey, Ettinghausen says: 'devotion, if not mania' for pretty flowers was prevalent everywhere.[617] Al-Fustat, in Cairo, with its

[609] F.B. Artz: *The Mind;* op cit; pp 148-50.
[610] Z. Oldenbourg: *The Crusades*; op cit; p. 476.
[611] S.P. Scott: *History;* op cit; Vol 3; pp 520-2.
[612] In C. Lloyd: *English Corsairs on the Barbary Coast* (Collins; London; 1981), p. 28.
[613] A.M. Watson: *Agricultural Innovation in the Early Islamic World* (Cambridge University Press; 1983), p.117.
[614] Z. Oldenbourg: *The Crusades*; op cit; p. 476.
[615] Al-Bakri: Description: 9 ff; Torres Balbas: La Ruinas; 275 ff; G.Marcais: Les Jardins de l'Islam; all in A. Watson: *Agricultural Innovation*; op cit; p. 118.
[616] R. Ettinghausen: Introduction; in *The Islamic Garden*, Ed by E.B. MacDougall and R. Ettinghausen (Dumbarton Oaks; Washington; 1976), p. 3.
[617] Ibid; p.5.

multi-storey dwellings, had thousands of private gardens, some of great splendour.[618]

In contrast, Western Europe could not compare on any front with the Muslim East.[619] Compared to Baghdad, Paris, Mainz, London and Milan were not even like modern provincial cities compared to a capital. 'They were little better than African villages or townships, where only the churches and the occasionally princely residence bore witness that this was an important centre.'[620] The streets of both Paris and London were receptacles of filth, and often impassable; at all times dominated by outlaws; the source of every disease, the scene of every crime.[621] The mortality of the plague was a convincing proof of the unsanitary conditions that everywhere prevailed; the supply of water derived from the polluted river or from wells reeking with contamination.[622] Medieval Muslim visitors to Christian towns complained-as Christian visitors now to Muslim towns do of the filth and smell of the "infidel cities."[623] At Cambridge, now so beautiful and clean, sewage and offal ran along open gutters in the streets, and "gave out an abominable stench, so . . . that many masters and scholars fell sick thereof."[624] In the thirteenth century some cities had aqueducts, sewers, and public latrines; in most cities rain was relied upon to carry away refuse; the pollution of wells made typhoid cases numerous; and the water used for baking and brewing was usually-north of the Alps-drawn from the same streams that received the sewage of the towns.[625] Italy was more advanced, largely through its Roman legacy, and through the enlightened legislation of Frederick II for refuse disposal; but malarial infection from surrounding swamps made Rome unhealthy, killed many dignitaries and visitors, and occasionally saved the city from hostile armies that succumbed to fever amid their victories.[626]

A third, and final, stereotype about the Islamic city, as already noted above, is with regard to the segregation of races and ethnic groups. This again has no hold in reality. There has never been in Islam anything of the segregation approaching the American southern states, or South African

[618] G. Wiet: *Cairo, City of Art and Commerce* (Norman Oklahoma; 1964), pp. 17; 19; 22.
[619] Z. Oldenbourg: *The Crusades*; op cit; p. 497.
[620] Ibid.
[621] S.P. Scott: *History*; op cit; Vol 3; pp 520-2.
[622] Ibid.
[623] Munro and Sellery; p. 266 in W. Durant: *The Age of Faith*; op cit; p. 1003.
[624] In Coulton: Panorama; 304 in W. Durant: *The Age of Faith*; op cit; p. 1003.
[625] Jackson: Byzantine and Romanesque Architecture; I; p. 142. Barnes: Economic History; p. 165 in W. Durant: *The Age of Faith*; op cit; p. 1003.
[626] W. Durant: *The Age of Faith*; op cit; p. 1003.

apartheid system, or in most modern Western agglomerations today. Islam is not segregationist either as a faith or society.[627] Van Ess observes that there were no ghettos in the Islamic world all the way down to modern times. Members of the same religious community often lived in the same quarter for reasons of family solidarity; but they were not kept apart from Muslims deliberately and on principle. In particular, they were not unclean; they could be invited to dinner.[628] Throughout the Muslim world, whether under the Arabs, or the Turks, all ethnic groups and faiths, had access on equal terms to every single amenity or service, and they formed part of the Islamic whole, and shared in opportunities, and even at the highest echelons of power.[629] The Jews in Cairo, for instance, are mentioned as practicing the professions of medical doctors, artisans, accountants, and despite professional specialisation, there is no instance of segregation of populations on ethnic or lines of faith with regard to professions and trades.[630] The same was true in Cordova, where under Islam, there is no evidence of a segregation of the Jewish population from its Islamic counterpart.[631] There is in fact plenty of evidence showing quite the reverse, a dense intermingling of faiths, which also includes the mozarabs (Spanish Christians living under Muslim rule).[632] In fact, segregation in that city followed precisely the Christian taking of the city in 1236. As soon as the city was taken by the Castilian, one of their first measures was to remove both Muslim and Jewish populations, who were then forced to re-locate into isolated neighbourhoods, cut off from access to every form of land communication.[633] In the instance when the Islamic state intervened to allocate one particular place in a city to a particular group, this was based on the need to guarantee a right of space to a group of people who had lost their worldly rights and possessions elsewhere. For instance, when Al-Hakam I of Spain (r. 796-820) banished the Cordovans in the early 9th century, they were offered a part of Fes to resettle.[634] The

[627] I.e: G. E. Von Grunebaum: Medieval Islam; op cit; p. 177 and p.210. F. Artz: *The Mind*; op cit; p.137. Joseph Van Ess: Islamic Perspectives, in H. Kung et. al: *Christianity and the World Religions* (Doubleday; London, 1986), p.80.
[628] J Van Ess: Islamic Perspectives: op cit; p.104.
[629] Y Courbage, P Fargues: *Chretiens et Juifs dans l'Islam Arabe et Turc* (Payot, Paris, 1997), T.W. Arnold: *The Preaching of Islam* (Archibald Constable, Westminster, 1896); R. Garaudy: *Comment l'Homme devint Humain* (Editions J.A, 1978), p.197.
[630] D. Behrens Abouseif; S. Denoix, J.C. Garcin: Cairo: in *Grandes Villes*; op cit; pp. 177-203; p. 185.
[631] M. Acien Almansa and A. Vallejo Triano: Cordoue; op cit; p. 124.
[632] Ibid.
[633] Ibid; p. 118.
[634] E. Levi Provencal: La Fondation de Fes; in *Islam d'Occident* (Librairie Orientale et Americaine; Paris; 1948), pp. 1-32.

same happened with the Jews, who when banished by the Spaniards in 1492 found exactly the same space and rights in the Ottoman urban realm.[635] And they were not just settled in the new space, their social status rose, too. The startling rise of the new port of Algiers was largely due to the influx of Aragon Jews, even if the port itself was established by Kheir-Eddin Barbarosa (early 16th century).[636] They achieved extraordinary pre-eminence in Morocco, too, during the 16th century.[637] And the same happened with the Muslims who were banished from Spain in 1609-10 and who were allocated parts of towns and cities, farming lands, trades and businesses from Morocco through Algeria to as far as Turkey and Syria.[638]

At all times, indeed, the Islamic city offered an image of a vast gathering of multiple faiths and races. Early Basra, for instance, had a substantial population of Hindus, Yemenis, Persians and Arabs.[639] Muslim Palermo in Sicily included Greeks, Lombards, Jews, Slavs, Berbers, Persians, Tatars and Black Africans.[640] The monk Theodosius, brought from Syracuse with Archbishop Sophronius in 883, acknowledged the grandeur of the new capital, describing it as:

> "Full of citizens and strangers, so that there seems to be collected there all the Saracen folk from East to West and from North to South... Blended with the Sicilians, the Greeks, the Lombards and the Jews, there are Arabs, Berbers, Persians, Tartars, Negroes, some wrapped in long robes and turbans, some clad in skins and some half naked; faces oval, square, or round, of every complexion and profile, beards and hair of every variety of colour or cut." [641]

[635] Y. Courbage, P. Fargues: *Chretiens et Juifs;* op cit.
[636] G. Fisher: *Barbary Legend* (Oxford at the Clarendon Press; Oxford; 1957), p.38.
[637] H.de Castries: *Une Description du Maroc sous le regne de Moulay Ahmed al-Mansour;* 1596 (Paris; 1909), pp. 119-20.
[638] K. Brown: An urban View of Moroccan History; Sale 1000-1800; in *Hesperis Tamuda;* 12 (1971), 46-63. R. Letourneau: *Fes avant le protectorat* (Paris; 1949), pp 79-94. J.D. Latham: Towards a study of Andalusian immigration and its place in Tunisian history; in *Cahiers de Tunisie*; 5 (1957), pp 203-52. H.Uzuncarsili: *Osmanli tarihi*; 2ed (Ankara; 1964), 2; p. 194 in A C. Hess: *The Forgotten Frontier* (The University of Chicago Press, Chicago and London, 1978), chap 6; p.121.
[639] N.L. Leclerc: *Histoire de la medicine Arabe.* 2 vols (Paris, 1876), vol ii, pp 279-82.
[640] Al-Maqqari *Nafh al-Tib*, ed. Muhammad M. Abd al-Hamid. 10 vols (Cairo, 1949), vol ii, pp 14-15; al-Khushani *Historia de los jueces de Cordoba por aljoxani*, ed. and tr. J. Ribera (Madrid, 1914), pp. 38-41, in A.M. Watson: *Agricultural Innovation;* op cit; p 92.
[641] In C. Waern: *Medieval Sicily* (Duckworth and Co; London; 1910), p. 19.

And these were no exceptional cases, as Watson points out.[642] What was true of Palermo in the 9th century was true of Algiers in the 17th; a city Lloyd says, which was not just clean and well disciplined, but also every visitor remarking on the law and order that prevailed in a city inhabited by persons of every nationality and religion.[643] The public baths of the city, Fisher notes, were made available to persons of all races and creeds, and even to slaves.[644]

Islamic buildings, too, in their design, just like the towns, cities and society, betrayed the same cosmopolitan spirit, as Durant notes:

> 'From the Alhambra in Spain to the Taj Mahal in India,' Islamic art overrode all limits of place and time, and 'laughed at distinction of race and blood.'[645]

2. Urban Imperatives:

Fast urban growth in the Islamic world today is symbol of, or synonymous with, chaos, which is in sharp contrast with medieval Islam. Then, urban growth proceeded alongside order, aesthetics, and inclusive of basic amenities. Udovitch has noted how Islamic cities provided economic opportunities, and with their mosques, madrasas, churches, synagogues, schools, bathhouses, etc, contained all that was needed for leading 'a religious and cultured life.'[646] Oldenbourg equally captures both comfort and fullness of Muslim urban life including necessary amenities as well as social and economic services.[647] A picture common to the better known cities such as Damascus, Baghdad, Cairo, and Cordova as well as other cities.[648] Damascus, for instance, was well supplied with parks, fountains, and public baths; a great commercial and manufacturing industry; public buildings, and great charitable foundations for the care of the sick, orphans, and the aged.[649] Each craft had its quarter, and on the outskirts of

[642] A.M. Watson: *Agricultural;* op cit; p 92.
[643] C. Lloyd: *English Corsairs on the Barbary Coast* (Collins; London; 1981), p. 25.
[644] G. Fisher: *Barbary*; op cit; p. 99.
[645] W. Durant: *The Age of Faith*; op cit; pp.270-1.
[646] A.L. Udovitch; Urbanism; op cit; p. 310.
[647] Z. Oldenbourg: *The Crusades*; op cit; p. 476.
[648] F.B. Artz: *The Mind*; op cit; pp.148-50.
[649] Ibid.

the city the landed aristocrats and the wealthier merchants had magnificent homes surrounded with gardens.[650] The contemporary Spanish traveller Ibn Jubayr described the city as 'the paradise of the East; mostly impressed by its hospitals and colleges, which he ranks among the 'great glories of Islam.'[651] Cordoba (Cordova), under the Romans, was in the words of Lombard 'an insignificant affair.'[652] Under the Muslims, the first Umayyad governor built walls, restored the old Roman bridge, and built water-mills on a jetty, using the river current.[653] Further transformations and additions were undertaken subsequently, especially in the 10th century under the reigns of Al-Hakam II, and Hisham II, and under Al-Mansur towards the end of the century. By the 11th century, the city was said to have 200,000 houses, a population of 600,000; 600 mosques, 900 public baths; nearly 100,000 trade establishments and shops; 50 hospitals, and a university with over 20,000 students.[654] The streets were cleaned, policed, and illuminated at night; water was brought to the public squares and to many of the houses by conduits; and crafts and trades thrived in their variety and multitude.[655] In 12th century Fes, under the Almohads, writes a chronicler, there were seven hundred and eighty five mosques and zawiyas; 240 places of convenience and purification, and 80 public fountains, which were all fed with water from springs and brooks. There were 93 public baths and 472 mills within and alongside the walls, not counting those outside the city. The same chronicler goes on to mention 89,036 dwelling houses, 19041 warehouses, 467 funduqs for the convenience of merchants, travellers, and the homeless; 9082 shops, two commercial districts, one in the Andalusian district, near the river Masmuda, and the other in the Kairaounese district; 3064 workshops, 117 public wash-houses; 86 tanneries; 116 dye works; 12 copper-smitheries; and 400 paper making shops.[656]

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[650] Ibid.

[651] Ibn Jubayr: *The Travels of Ibn Jubayr*; translated from the original Arabic with introduction and notes, by R.J. C. Broadhurst (Jonathan cape, London, 1952), p. 256.

[652] M.Lombard: *The Golden*; op cit; p. 140.

[653] Ibid.

[654] F.B. Artz: *The Mind*; op cit; pp. 148-50.
- I. R and L.L. al Faruqi: *The Cultural Atlas of Islam* (Mc Millan Publishing Company New York, 1986), p 319.
-W. Durant: *The Age of Faith*; op cit; p. 302.
-R. Hillenbrand: Cordova: *The Dictionary of the Middle Ages*; op cit; vol 3; pp 598-601.

[655] F.B. Artz: *The Mind*; op cit; pp. 148-50;- al Faruqi: *The Cultural Atlas,* p 319; W.Durant: *The Age of Faith*; op cit; p. 302; R.Hillenbrand: Cordova; op cit.

[656] Rawd al-Qirtas in T.Burckhardt: *Fez City of Islam* (The Islamic Text Society; Cambridge; 1992), p.73.

The economic sustenance of the Islamic city was no less crucial. Durant points out that cities and towns swelled and hummed with transport, barter, and sale; pedlars cried their wares to latticed windows; shops dangled their stock and resounded with haggling; fairs, markets, and bazaars gathered merchandise, merchants, buyers, and poets; caravans bound to China and India, to Persia, Syria, and Egypt; and ports like Baghdad, Basra, Aden, Cairo, and Alexandria sent Arab merchantmen out to sea.[657] The workshops of Cordoba employed 13,000 weavers, as well as its armourers and leather workers, whose products were famous throughout the civilised world.[658] The city innovated in the manufacturing of crystal; its woollens, silks, brocades and craftsmanship in embossed goat leather were all very much prized in foreign markets; and so were its jewellery and ivory carving.[659] In Konya, the Turkish Seljuk capital, Greek and Armenian carpet merchants continued to gather for centuries after its greatness was past.[660] The city had a new market place and shops of all kinds, and included caravanserais, built like basilicas, with high-arched aisles to accommodate the camels.[661] The vast market gardens stretching below the walls into the Anatolian plain were aimed for the supply of its large population.[662] In Samarra, likewise, a market area was built, and smaller markets, called *suwayqat*, dealt in basic commodities, specifically, foodstuffs such as grains and meat and other unspecified necessities.[663] The area across the river had a 'certain bucolic quality' and was characterized by some twelve villages situated along major water channels; the evidence indicating a flourishing agriculture, including excellent cash crops, and the taxes earned on the west bank properties represented some 60 percent of the entire tax base for the city.[664] Urban-rural complementarities in Muslim Spanish towns developed quickly from the 8th century onwards, the international market encouraging concentration of artisan industries in towns whose monetary economy allowed the urban middle class to buy into the surrounding countryside, thus developing tightly interdependent town-huerta (belts of irrigated parcels) complexes whose agricultural surpluses stimulated both urban economic and demographic growth.[665] Not only were the huertas

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[657] W. Durant: *The Age of Faith*; op cit; p. 208.

[658] C. Dawson: *Medieval Essays* (Sheed and Ward: London; 1953), p. 220.

[659] F.B. Artz: *The Mind*; op cit; pp. 148-50; Al- Faruqi: *The Cultural Atlas,* p 319; W. Durant: *The Age of Faith*; op cit; p. 302.R.Hillenbrand: Cordova; op cit.

[660] F.F. Armesto: *Millennium* (A Touchstone Book; New York; 1995), pp. 97-9.

[661] Ibid.

[662] Ibid.

[663] J. Lassner: Samarra; *Dictionary of Middle Ages;* op cit; pp. 642.

[664] Ibid; pp. 642-3.

[665] T. Glick: *Islamic and Christian*; op cit; p. 111.

surrounding most Andalusi towns closely connected with the economic life of the town, but the urban elite frequently owned country houses (*munyat*; Castilian, *almtinia*) dispersed throughout the huerta.[666] Extramural suburbs, Glick notes, tended to form along the most heavily travelled commercial roads leading from the town, or around palaces and military establishments; Cordova had more than twenty.[667] The list of thriving industries in each city, as recorded by contemporary geographers, and as outlined in the previous chapter, is long, and confirms the central place of cities in the social, cultural, and economic life of early Islam..

One of the dominant urban necessities is water supply. And should one ponder briefly on the chaos prevailing in the water supply of Middle Eastern and North African towns and cities today,[668] one marvels at the achievements of early Islam. Lapidus notes how early Islamic society understood that without an abundant supply of water, neither the necessities nor the amenities of civilisation could exist.[669] The quality of beverages depended on the purity of water; and without water, paper, leather, soap and dyed cloth could not be produced, nor in Islam could proper worship be carried on.[670] 'We can allow ourselves one generalisation about Muslim towns and cities,' holds Hill, in their times of prosperity, namely that they used a great deal of water not only for drinking and domestic purposes, but also for industrial uses, especially textile, and for public baths and fountains.[671] So medieval Islamic cities became recipients of extremely advanced systems of water management and supply, and for all purposes. In Samarra, where water has been brought by pack animals, feeder channels, which flowed year-round, were now extended from the river.[672] The Great thoroughfare extended on the outer limits of the city, and feeder channels that brought drinking water flanked it on either side.[673] Similar engineering skills were sponsored by

[666] Ibid; p.115-6.
[667] Ibid.
[668] K.Sutton-S.E. Zaimeche (1992) 'Water resource problems in Algeria.' *Mediterranee* 76. Aix en Provence, pp. 35-43.
S.E Zaimeche (1991): 'Feeding the population in semi arid lands: An assessment of the conditions of three North African countries: Morocco, Tunisia and Algeria.' *Maghreb Review*, Vol 16. Nos 3-4.; pp. 165-77.
[669] I.M. Lapidus: *Muslim Cities in the Later Middle Ages, (*Harvard University Press; Cambridge Mass; 1967), p. 69.
[670] Ibid; p. 70.
[671] D.R. Hill: *A History of Engineering in Classical and Medieval Times* (Croom Helm; 1984), p. 31.
[672] J. Lassner: Samarra; op cit; pp. 642-3.
[673] Ibid; pp. 643.

Zubaida, wife of Caliph Harun al-Rashid to supply Makkah with water.[674] Baghdad, with a population in excess of 800,000 (10th century) was served by a system of canals that gave the city access to the sea, stimulating its trade and manufacture.[675] In 993, the public baths in the city were counted and were found to number 1500.[676] Many more instances could be given for baths in cities and towns, and fountains in public and private estates.[677] Throughout the Muslim world, the typical system was the conduct of water by stream, canal, or qanat (underground conduit) into the city, where it was stored in cisterns, then, conduits from these cisterns, often underground, led to the various quarters, and into residences, public buildings and gardens.[678] The surplus water flowed out of the city into the irrigation system.[679] Of the Syrian cities, Damascus was most favoured with an extensive and complete water system. The rivers Barada, Qanawat, and Banyas supplied the city through two sets of underground canals, one for fresh water, which brought water to mosques, schools, baths, public fountains, and private homes, and the other for drainage.[680] During the reign of the Mamluk ruler, Tankiz (r.1312-1340), this system was cleaned, repaired, and overhauled to assure the distribution of water in the centre of the city.[681] Antioch enjoyed a plentiful supply of running water for its gardens and the consumption of its inhabitants; water was carried by miles of underground pipes to the more luxurious dwellings to provide water for fountains.[682] Samarkand had lead piping systems.[683] Water was conducted into it in a lead lined channel carried on a bridge, which was necessary due to the fact that the land around the city had been excavated to provide clay for the building of the city.[684] The geographer al-Istakhri (d. middle of 10th century) says that in the city, there is provision of water for the thirsty, and rarely did he see an inn, a street corner, or a square without arrangements for iced water in God's name.[685] He adds that the water

[674] G. Wiet et al: *History*; op cit; p.317.
[675] F.B. Artz: *The Mind;* op cit; 148-50.
[676] A.A. Duri: Baghdad; Encyclopaedia of Islam; vol 1; 1960; p. 899.
[677] D.R. Hill: *A History of Engineering*; op cit; p. 31.
[678] Ibid.
[679] This was the arrangement in many cities such as Zaranj in Sijistan, and Nisbin in northern Syria. See Ibn Hawqal: *Kitab surat al-Ard*; ed J.H. Kramers; 2nd ed of vol 2 (Brill; Leiden; 1938), p. 414; Ibn Jubayr: *Rihla*; Arabic text ed W. Wright (Brill; Leiden; 1852), 2nd ed by M. de Goeje (Brill; Leiden; 1907) p. 239.
[680] I.M. Lapidus: *Muslim Cities;* op cit; p. 70.
[681] Ibid.
[682] Z. Oldenbourg: *The Crusades*; op cit; p. 476.
[683] G. Wiet et al: *History*; op cit; at .p.316.
[684] Al-Istakhri: *Kitab Masalik wal-Mamlik*; ed. De Goeje (Leyden; 1927), p. 177.
[685] Ibid; p. 140.

circulates in an old moat of the fortress from where it is carried to the market by means of lead pipes.[686] Another medieval geographer, Al-Yaqubi (d. 897 or 905), holds that northern towns such as Qumm and Nishapur have underground water systems which supply water to the houses of the town.[687] Al-Muqaddasi, for his part, says that Makkah possesses three reservoirs which are filled from the canals dug by the order of Zubaida from Bustan Bani Amr.[688]

In the Muslim West, in Marrakech, water was brought to the city for drinking and irrigation by mainly subterranean canals from the mountains twenty miles to the south.[689] In Fes, the geographer Ibn Hawqal, in the 10th century, noted that its markets are washed daily, whilst three centuries later, it is observed, most homes are crossed by 'streams,' and in each house, regardless of its size, there is a saqqia (running fountain).[690] Water in the city is also used to wash the streets and to operate between 300 and 400 waterwheels.[691] The urban facilities of Algiers were of high quality, its water supply drawn from cisterns outside the walls, was later enlarged with the construction of aqueducts under Ottoman supervision by a refugee engineer from Grenada.[692] At Al-Qayrawan, in Tunisia, centuries earlier, an underground system, 25 kilometres distant from the city, filled a large decantation basin, from where water passed to another larger one, which then took water to the city, both basins dating from the 9th century Aghlabid era.[693] In the same country, at al-Mehdia, the geographer al-Bakri describes in great detail the engineering works which carried waters of the Meyanech to the great mosque, relying on aqueducts and large water raising wheels.[694] When the Muslims entered Sicily in the 9th century, they established new irrigation techniques, built public baths, and introduced water in many forms to garden and courtyard.[695] In Spain, the Guadalquivir (The Great River) was spanned by a noble bridge of seventeen arches, which, Poole says, 'testifies to the engineering powers of the Muslims.'[696]

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[686] Ibid; p. 216.
[687] Al-Yaqubi: *Kitab al-Buldan*; ed. De Goeje (Leyden; 1891), p. 274.
[688] Al-Muqaddasi: *Ahsan al-Taqasim*; (De Goeje ed) op cit; p. 74.
[689] M. Brett: Marrakech in *Dictionary of the Middle Ages*; op cit; vol 8; pp 150-1.
[690] H. Ferhat: Fes; in *Grandes Villes Mediterraneenes;* op cit; pp. 215-33; p. 225.
[691] Ibid.
[692] W. Spencer: the Urban Achievements in Islam: Some Historical considerations; in *Proceedings of the First International Symposium for the History of Arabic Science* (Aleppo; 1976), pp. 249-60; at p. 259.
[693] G. Marcais: l'Urbanisme; op cit; p. 226.
[694] Al-Bakri in G. Marcais: l'Urbanisme; op cit; p. 226.
[695] J. Lehrman: Gardens; Islam; in T*he Oxford Companion to Gardens*; ed by G. Jellicoe et al (Oxford University Press; 1986), pp. 277-80 at p. 279.
[696] S. Lane-Poole: *The Moors in Spain* (Fisher Unwin; London; 1888), pp. 135.

In Seville, the Almohads put an end to the labours of the water carriers by the construction of an Aqueduct; 10th century Andalusia, Scott observes, being traversed in every direction by magnificent aqueducts, whilst Cordova was a city of fountains.[697] The principle of the siphon, Scott also notes, was familiar to the Muslims eight hundred years before it was known in France, and was utilized to a remarkable degree in the Muslim Hydraulic system.[698] An excellent detailed illustration of how the siphon was developed by Muslim mechanical engineers can be found in the *Kitab al-Hayal* by the Banu Musa brothers (fl early 9th century).[699]

Baths dominated the Islamic urban and social landscape, and were found alongside numerous pools; frequent washing part of religious duty for Muslims.[700] Hot baths were thus in use in the Muslim world from the 7th century onwards.[701] The great cities of the East possessed conduits of running water; and everywhere could be found many pools and baths.[702] The baths of Damascus, meticulously constructed, were numerous; the historian, Ibn al-Asakir pointing out that during his era, the second half of the 12th century, there were forty public baths within Damascus, and another seventeen in its suburbs.[703] Two centuries before him, the geographer al-Muqaddasi, when in the city, exclaimed: 'There are no baths more beautiful, no fountains more wonderful.'[704] In his time, water was piped from the hot springs in Tiberias to Damascus' hot baths.[705] Many such baths were still working in 1914, 24 hours a day, and they were also hostels for travellers coming from distant lands to spend a night in warmth and comfort.[706] In Aleppo, in the middle of the 13th century, Ibn Shadad counted 70 baths in the city itself and another 93 in the suburbs, to which could be added thirty or so private baths.[707] In Algiers, great care was lavished on the hammams (baths), two of which were constructed by high ranking officials for the public at private expense.[708] In Muslim

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[697] S.P. Scott: *History*; vol 3; op cit; p. 520.
[698] Ibid; vol 2; p. 601.
[699] A. Bir: *The Book of Kitab al-Hiyal of Banu Musa Bin Shakir* (IRCICA; Istanbul; 1990).
[700] Z. Oldenbourg: *The Crusades*; op cit; p. 476.
[701] D.R. Hill: *A History of Engineering*; op cit; p. 44.
[702] Z. Oldenbourg: *The Crusades;* op cit; p. 476.
[703] Referred to by Thierry Bianquis: Damas in *Grandes Villes Mediterraneenes;* op cit; pp. 37-55; at p. 46.
[704] Al-Muqaddasi: *Ahssan al-taqassim;* op cit; p. 157.
[705] Al-Istakhri: *Kitab al-masalik wa'l Mamlik;* ed. M.G. al-Hini (Cairo; 1961), pp. 44-5.
[706] T. Bianquis: Damas; op cit; p. 46.
[707] Ibn Shadad: *Al-Alaq al-Khatira*; Ed D. Sourdel (Damascus; 1953), pp. 291-302; in A.M. Edde: Alep; in *Grandes Villes Mediterraneenes;* op cit; pp 157-75; at p.166.
[708] W. Spencer: the Urban Achievements; op cit; p. 259.

Spain, public baths could be found even in the smallest village; in the middle of the 10th century, Cordova alone had 900, whilst, as Scott notes, in the 18th century, in contrast, there were not as many in all of Europe.[709] The Muslims were in the habit of taking a bath daily, and accordingly, baths were generally reserved for men in the mornings and women in the afternoons.[710]

The baths were built on the traditional plan: a vestibule for undressing followed by a number of rooms, each of which was hotter than the other serially, and finally a cooler one for re-adjustment to the external temperature.[711] Writing early in the 14th century, the Egyptian Ibn al-Ukhuwwa describes the bath as having three chambers:

> 'The first chamber is to cool and moisten, the second heats and relaxes, the third heats and dries.'[712]

The baths and the supply tank had to be thoroughly cleaned every day.[713]

Like most aspects of Islamic civilisation, baths had an intricate link with the faith, while the medieval Christians forbade washing as a heathen custom. Lane Poole notes:

> 'The monks and nuns boasted of their filthiness, insomuch that a lady saint recorded with pride the fact that up to the age of sixty she had never washed any part of her body, except the tips of her fingers when she was going to take the mass. While dirt was characteristic of Christian sanctity, the Muslims were careful in the most minute particulars of cleanliness, and dared not approach their God until their bodies were purified.'[714]

The elimination of Islam from Spain thus required the destruction of baths, both public and private.[715] One of the first acts of Isabella after the conquest of Grenada (1492) was the demolition of baths on account:

> 'Of the scandal the sight of apartments devoted to ablution and luxury caused every good Christian, as well as for the reason that their use was always considered entirely superfluous in a monastic institution.'[716]

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[709] S.P. Scott: *History;* op cit; vol 3; pp 520-2.
[710] S.M. Imamuddin: *Muslim;* op cit; p. 208.
[711] Ibid; p. 209.
[712] Ibn Al-Ukhuwwa: *Ma'alim al-Qurba fi Ahkam al-Hisba*; ed R. Levy; Arabic text with abridged English translation (Gibb Memorial Series) (London; New Series; 1938), pp. 149 ff.
[713] D.R. Hill: *A History of Engineering;* op cit; p. 44.
[714] S. Lane Poole: *The Moors*; op cit; pp. 135-6.
[715] T.B. Irving: Dates, Names and Places: The end of Islamic Spain; in *Revue d'Histoire Maghrebine;* No 61-62 (1991); pp 77-93; p.85.
[716] S.P. Scott: *History;* op cit; Vol II, p.261.

Philip II (1527-1598) ordered the destruction of all public baths on the ground that they were relics of infidelity.[717] Recurrently measures were passed that all baths, public and private were to be destroyed, and that no one in future was to use them.[718] As an earnest enforcement, all baths were forthwith destroyed, commencing with those of the king.[719] Everyone clean and neat gave the suspicion of being a Muslim who regularly performed their 'ablutions'.[720] One, Bartolome Sanchez, appeared in the Toledo Auto da fe of 1597 for bathing, and although overcoming torture, he was finally brought to confess and was punished with three years in the galleys, and perpetual prison and confiscation.[721] Michael Canete, a gardener, for washing himself in the fields while at work, was tried in 1606: there was nothing else against him but he was tortured.[722]

Marcais insists that it is entirely erroneous to believe that the Muslims released their used waters, sewage, or refuse to the street.[723] This is another prevailing stereotype in most writing on Islamic medieval cities. Sanitary regulations were, in fact, maintained to a high degree, and a thorough system of drainage prevailed. Seven centuries after the cities of Spain had been drained by a system of great sewers, their streets kept free from rubbish, and subjected to daily cleansing, Scott observes, Paris was still worthy of its ancient appellation of Lutetia, "The Muddy;" the way of the pedestrian was blocked by heaps of steaming offal and garbage; and droves of swine, the only scavengers, roamed unmolested through court-yard and thoroughfare.'[724] Sewage systems under the city of Valencia were large enough to admit a cart with ease, and the smallest could be traversed by a loaded beast of burden.[725] Cordoba was well equipped with a good sewage system, which made it possible to evacuate waste.[726] In the cities of the East, Oldenbourg notes, the conditions of hygiene and comfort were closer to those of the 19th century than to anything in the Middle Ages.[727] And so it was in North Africa, even in flat cities such as Al-

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[717] S. Lane Poole: *The Moors;* op cit; pp. 135-6.
[718] Luis del Marmol Carbajal: *Rebelion y castigo de los Moriscos de Granada* (Bibliotheca de autores espanoles, Tom. XXI). pp. 161-2.
[719] H. C. Lea: *A History of the Inquisition of Spain*, 4 vols (The Mac Millan Company, New York, 1907), vol 3; p.336
[720] T.B. Irving: Dates, names and places; op cit; p.81.
[721] H.C. Lea: *The Moriscos of Spain*; Burt Franklin; New York; 1968 reprint; p.129.
[722] Ibid.
[723] G. Marcais: l'Urbanisme; op cit; p. 226.
[724] S.P. Scott: *History;* op cit; vol 3; pp 520-2.
[725] Ibid; vol 1; p. 613.
[726] M. Acien Almansa and A. Vallejo Triano: Cordoue; op cit; p. 126.
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[727] Z. Oldenbourg: *The Crusades*; op cit; p. 498.

Qayrawan, where such a system would have been hard to establish; and so effective it was that when the French entered the city of Fes (early in the 20th century), they found the system adequate enough to leave it untouched.[728] And this applies to other areas; excavation showing this to be the case in Fustat (Cairo), where each house, probably, had its own cesspool, in some cases linked by piping to a general drainage network.[729] The task of making certain that the whole sewage system worked fell to the urban sewage cleaner, operating as part of the city corporation, under the jurisdiction of the Muhtasib.[730]

Central in the provision and upkeep of all such works and structures were strictly Islamic, religious endowments, *waqfs*. The provision of drinking water, which as noted, was considered a meritorious action, resulted in many individuals building qanats and constituting them into waqfs, whether in a town, or a particular quarter of a city.[731] In Tunis, water supply was taken in charge by both central administration and religious endowments.[732] Often, the founder laid down the rules, as in one instance, that the water, when it reached the town, should be let into the houses and cisterns, and that as soon as one place had taken water, the remainder should be let into the next place, and that at times when water was scarce, no one should use more than was necessary.[733] The founder also stipulated that rice should not be cultivated with the water of the waqf, which has to flow into the town. Many wells, as well as fountains, in both bazaars and streets of towns were also constituted into waqfs.[734]
And once more, the role of the Muhtasib, the State Inspector, comes to the fore. Drinking water in the towns came under his general supervision, and if water conduits were in a state of disrepair, it was his duty to have them repaired, and under certain situations could order the townspeople to do so, and if the source of drinking water was fouled, he could order them to rectify the matter.[735]

Health and social issues, equally, in both their foundation, management and upkeep, were the result of strictly Islamic forms of organisation,

[728] G. Marcais: l'Urbanisme; op cit; p. 227.
[729] G. Wiet et al: *History*; op cit; p.318.
[730] G. Marcais: l'Urbanisme; op cit; p. 226.
[731] A.K.S. Lambton: Ma'; in *Encyclopaedia of Islam*; op cit; vol 5; new series; at p. 876.
[732] S. Denoix: Bilans in *Grandes Villes*; op cit; p. 294.
[733] A.K.S. Lambton: Ma'; op cit; p. 876.
[734] Abd al-Husyan Sipinta: *Tarikhiya-yi awkaf-I Isfahan*; 1967; p. 360 in A.K.S. Lambton: Ma'; op cit; p. 876.
[735] R. Levey: *The Social Structure of Islam* (Cambridge; 1957), p. 337.

especially religious endowments, complemented by measures from the central authority. The latter was heavily involved in the construction and setting up of hospitals and hostels, for instance.[736] One of the earliest hospitals was established in old Cairo, at al-Fustat, in 872 by Ibn Tulun, a former slave of Turkish origin, who rose in the military ranks to become governor of the city. In both construction and management, the hospital absorbed vast resources, which came chiefly from the bazaar and from other *waqfs (*endowments).[737] The patients were given a special garment and beds, and were served meals and medications, whilst physicians attended to the patients every day. Every Friday Ibn-Tulun visited the hospital, inspected the supplies, conferred with the physicians and visited the patients.[738] Elsewhere, in Aleppo, it is known that a share of profits from lands and orchards, mills and shops, and baths were constituted into waqfs, and were devoted to the financing of mosques, madrasas, and hospitals.[739] Nur Eddin Zangi (r. 1146-1174) instituted a waqf for a hospital for destitute men in Aleppo, which was extended in 1257 to also include a ward for women.[740] This hospital, which was further transformed in the Mamluk period, was mainly to serve the poorer sections of the population.[741] In the Mamluk period other hospitals were established for the same purposes.[742] A number of Muslim hospitals, such as the Adudi in Baghdad, the Qala'un in Cairo and the Mansur in Marrakech, were outstanding in the size of the buildings, their furnishings and equipment, and the quality of their staff.[743] Even allowing for the oriental tendency to exaggerate, Whipple points out, their wealth and revenues made possible the magnificence of these establishments.[744] The director had charge of the administration, supervision of the supplies and medicaments and the furnishing of the hospital; in some instances he had charge of the *waqfs* of the hospital, but the actual professional work was left to the physicians, in the hands of the physician-in-chief or dean, assisted by the heads of the different specialties.[745] As for the hostels,

[736] A.M. Edde: Alep; in *Grandes Villes Mediterraneenes;* op cit; pp 157-75; at p. 169.
[737] A. Whipple: *The Role of the Nestorians and Muslims in the History of Medicine;* facsimile of the original book, produced in 1977 by microfilm-xerography by University Microfilms International (Ann Arbor, Michigan, U.S.A; 1977), p. 93; and A Issa Bey: *Histoire des hopitaux en Islam*; Beirut; Dar ar ra'id al'arabi; 1981; pp. 112-5.
[738] A Issa Bey: *Histoire;* op cit; pp. 112-5.
[739] S. Denoix: Bilans, in *Grandes Villes Mediterraneenes;* op cit; p. 294.
[740] Ibid.
[741] A.M. Edde: Alep; op cit; p. 169.
[742] Ibid.
[743] A. Whipple: *The Role*; op cit; p. 80.
[744] Ibid.
[745] Ibid; p. 81.

some of their aims were to provide shelter to the poor, the elderly, or those without family or relatives to care for them.[746] There were also hostels for the care of poor women, widows, divorced, and unmarried girls, who could not be taken in charge by their relatives.[747] Endowments (waqfs) financed such institutions, under the Mamluks, for instance, many waqfs funded hospitals and also convents for the poor.[748] All these services relied largely on group solidarity.[749] This was possible because the Muslim does not just have the personal duty imposed by the faith to help those in distress, through the zaqat (alms), one of the five pillars of Islam, but also in all Islamic cities was found a network aimed for the care of the sick, the poor, women, or those whose relatives failed to care for.[750]

Order and security in the Islamic city, finally, were early imperatives, too. All cities had a police force, in Baghdad, the *Sahib al-Shurta* (the Police Chief) being the most powerful figure in the urban administration.[751] In Aleppo, various institutions of Seljuk origin policed the city.[752] The same in the Islamic West, such as in Tunis, where the city centre was policed, and so were the suburbs and the surrounding gardens, as well as the markets.[753] In the same country, in Al-Qayrawan, the police deployed agents watching public order, and was under the command of a chief who was second in power to the local governor.[754] The *Wali al-Madina*, or the city's local governor, a man of the law, has the duty to ensure order in the city. There was also a wide distribution of police stations within the city.[755] In Spanish cities, Scott and Glick note, order was kept by a strong and well-organised police, patrolling the thoroughfares day and night.[756] Cordoba was policed by at least three distinct forces, each of them with its specific functions.[757]

[746] A.M. Edde: Alep; op cit; p. 169.
[747] Ibid.
[748] S. Denoix: Bilans; op cit; p. 294.
[749] D. Behrens Abouseif; S. Denoix, J.C. Garcin: Cairo: in *Grandes Villes;* op cit; p. 194.
[750] Ibid.
[751] S. Denoix: Bilans; op cit; p. 287.
[752] Ibid.
[753] Ibid.
[754] M. Sakly: Kairouan in *Grandes Villes Mediterraneenes*; op cit; pp. 57-85; p. 73.
[755] Ibid.
[756] T. Glick: *Islamic*; op cit; p. 115. S.P. Scott: *History*; op cit.
[757] M. Acien Almansa and A. Vallejo Triano: Cordoue; op cit; pp 117-34; at p. 128.

3. Construction Skills, Aesthetics, and Historical Misrepresentations:

> 'It is only necessary to go through the literary and artistic works of the Arabs,' [says Le Bon] 'to notice that they always sought to embellish nature. The characteristic of Arabic art is imagination, the brilliant, splendour, exuberance in decoration, fantasy in the details. A race of poets- and poets doubled with artists. Having become rich enough to achieve all their dreams, they bred those fantastic palaces which seem to be sculptures of marbles engraved with gold and precious metals. No other people has possessed such marvels, and none will ever posses them. They correspond to an age of youth and illusion gone for ever. It is not this epoch of cold and utilitarian banality, which humanity has now entered where they could be sought.'[758]

The same impression conveyed by Talbot Rice:

> 'The Period of Samarra's supremacy (836-83), so far as art was concerned, was one of the most brilliant in Islamic history; at no time before had so much been built in so short a space of time or had such elaborate decorations been devoted to so large a number of houses as well as mosques and palaces. As one wanders over this immense field of ruins one can but marvel at the age which was responsible for such lavishness.'[759]

Madinat al-Zahra (in Cordova) is mesmerizing in Scott's words:

> 'From a royal villa, Medina al-Zahra insensibly expanded into a miniature city. Around the palace clustered the luxurious dwellings of the courtiers, the merchants, and the officers of the army. The avenues were lined with trees, whose foliage formed a continuous arch. Not a house could be seen that was not embosomed in gardens abounding with gushing water and rare exotics. Even the sides of the Sierra had been stripped of the sombre growth of the evergreens which had originally covered them, and, planted with fig and almond trees, appeared in all the beauty of luxuriant foliage and fragrant blossoms. Not far away, extensive plantations of the sweetest of flowers gave to the

[758] G Le Bon: *La Civilisation;* op cit; p. 402.
[759] D. Talbot Rice: *Islamic Art* (Thames and Hudson; London; 1979 ed), p. 97.

locality the name of Gebal al-Wardat, the Mountain of the Rose.'[760]

There is a specialised Western literature in praise of Islam's construction skills and aesthetic accomplishments seen in buildings such as the Great Mosque of Damascus, The Dome of the Rock in Jerusalem, the Alhambra in Grenada, the Blue Mosque of Istanbul etc. Lambert, Grabbar, Harvey, Talbot Rice, Creswell, Marcais, Ettinghausen, and others, have brought to general appreciation such Islamic greatness.[761] Creswell, for instance, makes an excellent case for the walls and Baghdad gate of Raqqa, the fortified palace of Ukhaidir, 120 miles south of Baghdad, or the buildings of Samarra.[762]

Mainstream Western literature dealing with Islamic history and civilisation, however, offers a completely different, derogatory picture, and tends to paint Muslims, some dynasties, in particular, as wholly incapable of any construction or architectural skills. The Seljuks are amongst the dynasties that have been brutalised by nearly all Western historians. Hence, Ashtor, supposedly a leading expert on Islamic cultural, social and economic history, devotes a considerable proportion of his work lashing out at every aspect of the Seljuk history. In relation to their (lack of) construction skills, he says, for instance:

> 'The attentive reader of the Arabic chronicles of the Seljukid age becomes aware of these facts at time and again he comes across reports of bridges falling down and dams bursting. For often the chronicler reveals that it was not simply the consequence of negligence but of bad construction and ineffective repairs.'[763]

A general picture of Seljuk ineptness in the field is shared by mainstream historians.[764]

Looking at historical evidence, however, once more, fundamentally contradicts this picture. During the crusades, the Seljuks were always

[760] S.P. Scott: *History;* op cit; vol 1; p. 630.
[761] See for instance:
-K.A.C. Creswell: *Early Muslim Architecture*, 2 Vols (1932-40).
-E. Male: *Art et artistes du Moyen Age* (Paris 1927), pp. 30-88.
-G. Marcais: *Manuel d'Art Musulman* (Paris; 1926).
-G. Marcais: *l'Architecture Musulmane d'Occident*, Paris 1954.
-H. Terrasse: *L'Art hispano mauresque des origins au 13em siecle* (Paris; 1933).
[762] K.A.C. Creswell: *A Short Account on early Islamic Architecture* (Scholar Press; 1989).
[763] E. Ashtor: *A Social and Economic History of the Near East in the Middle Ages* (Collins; London; 1976), p.244.
[764] G. Wiet et al: *History*; op cit; pp. 7; 156-7; 243 etc. F.B. Artz: *The Mind;* op cit; p. 175-6; D. Campbell: *Arabian Medicine*; op cit; etc (see also final part, the section on Orthodoxy).

prompt to repair any damaged structures, whether in time of peace or war, at Nicaea, for instance, during the first crusade, an attempt by the crusaders to cause the city walls to collapse by mining was repaired overnight.[765] Seljuk engineering skills were in fact so advanced that the crusaders learnt from them the art of fixing bridges and structures falling into disrepair, or following earthquakes.[766] The Seljuk capital Konya, towards the end of the 12th century, is impressive, a sizeable and splendid city 'of the size of Cologne', according to contemporary Western visitors.[767] It was laid in the form of a rectangle with rounded corners, and was enclosed by 108 great stone towers; the Pentagonal citadel built surrounding the hill.[768] A palace kiosk rivalled the honeycomb vaulted interior of the Capella Palatina at Palermo; the inside of the cupola of the Buyuk Kataray Medrese, decorated in the mid 13th century still glimmers in blue and gold on triangular pendentives.[769] The caravanserais, built like basilicas, had high-arched aisles.[770] The mosque of Ani in Armenia; the magnificent portal of the mosque of Diwrigi in Konya; the immense mosque of Ala-Uddin; the cavernous porch and embroidery like facade of the Sirtjeli Madrasa; the Great Mosque of Mosul; the tower of Tughril Beg at Rayy; the tomb of Sinjar at Merw; the dazzling mihrab of the Alaviyan Mosque at Hamadan; the ribbed vault and unique squinches of the Friday Mosque at Qasvin, and there, too, the great arches and mihrab of the Haydaria Mosque: these are but a few of the structures that remain to prove the skill of Seljuk architects and the taste of Seljuk kings, Durant notes.[771] But more beautiful than any of these, Durant continues, is the masterpiece of the Seljuk age, the Masjid-i-Jami, or Friday Mosque, of Isfahan. Like Chartres or Notre Dame, it bears the labour and stamp of many centuries; begun in 1088, it was several times restored or enlarged, and reached its present form only in 1612, but the larger of the great brick domes carries the inscription of Nizam al Mulk (Seljuk minister d. 1092), and the date 1088.[772] The porch and the sanctuary portals, one eighty feet high, are adorned with mosaic tiles hardly rivalled in all the history of that art; the inner halls are roofed with ribbed vaults, complex squinches and pointed arches springing from massive piers. The mihrab (1310) has a

[765] M. Erbstosser: *The Crusades;* op cit; p. 123
[766] J. Harvey: The Development of Architecture, in *The Flowering of the Middle Ages*; ed J. Evans (Thames and Hudson; 1985), pp. 85-106.
[767] F.F. Armesto: *Millennium* (A Touchstone Book; New York; 1995), pp. 97-9.
[768] Ibid.
[769] Ibid.
[770] Ibid.
[771] W. Durant: *The Age of Faith*; op cit; pp. 316-7.
[772] Ibid.

stucco relief of vine and lotus foliage, and Kufic lettering, unsurpassed in Islam.[773] Concluding his account, Durant insists:

> 'Such monuments laugh out of court the notion that the Turks were barbarians. Just as the Seljuk rulers and viziers were among the most capable statesmen in history, so the Seljuk architects were among the most competent and courageous builders of an Age of Faith distinguished by massive and audacious designs. The Persian flair for ornament was checked by the heroic mood of the Seljuk style; and the union of the two moods brought an architectural outburst in Asia Minor, Iraq, and Iran, strangely contemporary with the Gothic flowering in France.'[774]

Also in praise of Seljuk achievements is Talbot Rice, who says:

> 'Though every part of the Islamic world was responsible for the production of works of art of every type, there seem, as we look back today, to be certain especially outstanding arts that we can associate with particular areas or ages; glass with Syria, pottery and miniatures with Persia, or metalwork with modern Mesopotamia, for example, and if we were to follow up this line of thought it would be certainly architecture and architectural decoration that we would associate with the Seljuk of Rum. All over Asia Minor there survive to this day a mass of mosques and madrasas in a very distinctive style and boasting decorations either in carved stone or tile work which are among the finest in all Islam.'[775]

Talbot Rice notes how the Seljuks were the first to develop fine buildings planned as caravanserais, some of which were of considerable size, some almost palaces, and their architecture of the finest sort.[776]

Other Islamic ethnic groups, Mamluks and Berbers, above all, are also presented by the majority of Western historians as lacking in skills and care for aesthetics.[777] This, once more, is contradicted by evidence. The Mamluk legacy, for instance, continued to influence Islamic art up to the 20th century.[778] In their time (mid 13th century onward), they erected hundreds of religious and secular edifices in Cairo, their capital, as well as

[773] Ibid.
[774] Ibid; pp. 317.
[775] D. Talbot Rice: *Islamic Art*; op cit; p. 165.
[776] Ibid; p. 165-6.
[777] Such as:
-C. Brockelmann: *History of the Islamic Peoples* (Routledge; London; 1950).
- E. Ashtor: *A Social and Economic History;* op cit.
[778] E. Atil: Mamluk art: *Dictionary of Middle Ages*; op cit; Vol 8; p. 69.

in the provinces, employing traditional plans, such as hypostyle mosques, four-'wan madrasas, and square mausoleums.[779] Their buildings were lavishly decorated with carved stone, stucco, and marble mosaics and panels, the most outstanding features of Mamluk architecture being soaring tiered minarets, massive carved domes and entrance portals, and marble mihrabs.[780] The elaborate floral and geometric patterns of the carved stone-work gave these structures their distinctly Mamluk character.[781]

Berber accomplishments, which will form a major part of discussion in the final part of this work, although generally denied were equally obvious. They can be seen in the 12th century, both in Spain and North Africa, under the Almohad dynasty.[782] The Giralda Tower of Seville, which took twenty five years to complete (1172-1195) is the work of the Almohads.[783] It first served as a minaret and observatory, being 300 feet tall, with a base of 43 square feet. It originally had four copper spheres on top which could be seen from miles away, but which were brought down by an earthquake.[784] It is today a cathedral tower from which one can contemplate a panoramic view of Seville and the Guadalquevir River.[785] The Great Mosque of Tlemcen (Western Algeria) (1082 restored in 1136) is typical of this phase; comparatively small, yet its ornament is lavish, whilst the horseshoe arch has been evolved to an exaggerated degree and the multi-lobed arches and the pierced stonework of the dome are amazingly intricate; which creates a 'picturesque and delightful' effect.[786]

It is common to find in most Western literature a countless amount of adverse assertions such as that Islamic buildings hardly rose above one floor due to lack of engineering skills, or that their interiors lacked in innovativeness, or that they neglected their immediate surroundings. Instances given under previous headings contradict this picture, and need not be repeated. Briefly here, in relation to some such arguments, evidence from medieval Al-Fustat (old Cairo), Syrian Tripoli and Tyre, shows that there were apartment houses of five, or even seven storeys high.[787] Evidence also contradicts the view of Muslim households packed in a mess without

[779] Ibid; pp. 69-70.
[780] Ibid.
[781] Ibid.
[782] D. Talbot Rice: *Islamic Art*; op cit; p. 149.
[783] A. Chejne: *Muslim Spain, Its History and Culture* (The University of Minnesota Press; Minneapolis; 1974), p. 367.
[784] Ibid.
[785] Ibid; p. 368.
[786] D. Talbot Price: *Islamic Art;* op cit; p. 149.
[787] G. Wiet et al: *History;* op cit; pp 317-8.

any consideration for the surrounding environment; 8th century cottages occupied by the lower classes of the Spanish Muslims, for instance, were according to Scott: 'embowered in roses, surrounded by fields of waving grain and orchards of luscious fruits, were furnished with all the comforts and many of the luxuries of life.'[788] Evidence also contradicts the assertion that Muslim buildings lacked inner innovativeness; Oriental master builders, for instance, in seeking to reinforce their structures, introduced rows of columns into the masonry to have binding effect; and from the 12th century onwards, the walls of ramparts and citadels often were strengthened by buttresses.[789] Private residences showed similar innovative spirit. Particular arrangements, for instance, were made to deal with the rigours of climate as during the hot season, the rich residents of Baghdad lived in cellars, whilst others made use of *punkahs*, which were large fans suspended from the ceiling; whilst the terraces of Cairo, in particular, generated summer ventilation by means of air-traps opening to the north.[790]

4. Impact from Within, and Impact on the West:

The point of departure of Islamic construction and design, obviously, is the mosque, and in a chronological order the first such mosque: the Prophet's (PBUH) Mosque. Artz in his thorough and lengthy description of this edifice and those that followed captures the central element of faith as the fundamental determinant of both design and decoration.[791] The Prophet's mosque was a small dwelling, built in 622 at Madinah under his direction, but to evolve, and serve as the model for most of the later mosques. The whole was a square enclosure, entirely surrounded by walls of brick and stone. One side of the enclosure was roofed with palm branches covered with mud and supported by palm trunks. The next mosque, built in today's Iraq in 639, was erected on exactly the same plan, but the roof was supported by marble columns. Within 80 or 90 years of the Madinah mosque, all the features of the congregational mosque had evolved. Inside the basic square plan was now added a large open forecourt with a fountain for ablutions in the centre and a shaded

[788] S.P. Scott: *History;* op cit; vol 3; pp 520-2.
[789] G. Wiet et al: *History;* op cit; p.317.
[790] Ibid; p.318.
[791] F.B. Artz: *The Mind*; op cit; pp. 172-4.

colonnade around the sides. Within, everything was arranged for the central act of worship: prayer. Prayer in Islam is more rewarded if performed in a group, and the first row is the most rewarded. Thus, as everyone wished to be near the front, the prayer area of the mosque was thus shaped in a rectangular form; the prayer hall of the Great Mosque at Damascus being 131 meters wide and only 38 meters deep. The annual pilgrimage to Makkah, from all parts of Islam, contributed greatly not only to the standardization of the form of the mosque and of other types of building. However, the structural materials used in both mosques (as in palaces,) (brick, stone, marble, or clay), depended on what was available in any particular region. Styles also varied, whether with respect to minarets, which followed, with some modifications, the traditional shape of the towers of the countries where they were built. The minaret was the tower from which was sent out the call to prayer.

The mosques (like the palaces), although severe externally, were lavishly decorated within with glazed tiles, low flat carvings known as arabesques, rich marble, and carpets; the mosques also had stained-glass windows. However, human and animal forms were strictly forbidden by the Qur'an. Islam also opposed luxury. "He who drinks from gold and silver vessels drinks the fire of Hell," says a Hadith (Prophetic Saying/Muslim tradition.) In order to avoid the forbidden, the Muslims, Artz adds, made vessels and tiles of earthenware and covered them with gold lustre; they inlaid steel, brass, copper, and bronze objects with fine bands of gold and silver; and they often carved their complicated arabesques in plaster, even in a place like the mihrab. The typical Islamic decoration was based on interlacing lines and geometric designs, and used much colour. Coloured tile and carved and painted arabesque are in fact the common decorative means of Islam. These were combined with the use, in ceilings, of stalactite forms and types of complicated coffering. The designs of both tiles and arabesques showed great taste, ingenuity, and inventiveness. Muslims Arabic calligraphy, 'the most beautiful that man has devised, as a common decorative motif,' as Artz holds, uses the text of the Qur'an.[792]

Durant explains the architectural revolution, which transformed the old courtyard of the mosque into the madrasa or collegiate mosque throughout Eastern Islam. As mosques increased in number, it was no longer necessary to design them with a large central court to hold a numerous congregation; and the rising demand for schools required new educational facilities.[793] From the mosque proper-now almost always crowned with a

[792] Ibid.
[793] W. Durant: *The Age of Faith*; op cit; pp. 317.

dominating dome-four wings or transepts spread, each with its own minarets, a richly decorated portal, and a spacious lecture hall. Normally each of the four 'orthodox' schools of Islamic theology and law had its own wing.[794] This revolution in design was continued by the Mamluks in mosques and tombs firmly built in stone, guarded with massive doors of damascened bronze, lit by windows of stained glass, and brilliant with mosaics, carvings in coloured stucco, and such enduring tiles 'as only Islam knew how to make.'[795]

The mosque of Cordova is certainly one of the most written about for its aesthetics as much as its impact on subsequent buildings.[796] In its earliest form it was a courtyard mosque of rectangular plan, with a sanctuary of eleven aisles akin to that of the original al-Aqsa mosque at Jerusalem and with horseshoe arches like those at Damascus topping the arcades.[797] Al-Maqqari supplies a large number of quotations from his predecessors who admired the mosque as the best and greatest ever built.[798] The mosque construction was begun by Abd Errahman I in 786, and was repeatedly enlarged in 833 by Abd Errahman II, and again in 965 by Al-Hakam II when the great dome in front of the mirhab was completed.[799] Abd Errahman III and his immediate successors introduced major alterations such as in 950, when he ordered the construction of a minaret 89 yards high.[800] Al-Hakam II built a dome for the mihrab, placed the minbar near it, and brought water to the mosque in canals made of stone.[801] Subsequent rulers such as al-Mansur (late 10th century) added further enlargements. The mosque is both a very remarkable structure and represents something quite new, notes Talbot Rice, for the dome is supported on a series of intersecting ribs.[802] The hexafoil arches in two tiers also represent a new and original departure in Islamic architecture.[803] In its final shape, the mosque contained the finest artistic expressions of the Andalusians, some say it had 360 arches, each receiving the rays of the sun every day of the year; 1,293 marble columns supporting its roofs, and its many ample doors were covered with finely decorated

[794] Ibid.
[795] Ibid.
[796] See, for instance, E. Lambert: Histoire de la Grande Mosquee de Cordoue, *Annales de l'Institut d'Etudes Orientales;* 2; 1963; A.A. Salem: Cronologia de la mezquita mayor de Cordoba; *Al-Andalus;* 19 (1954), etc.
[797] D. Talbot Rice: *Islamic Art;* op cit; p. 77.
[798] Al-Maqqari: *Nafh Al-Tibb*; op cit; vol 2; pp. 60 ff.
[799] D. Talbot Rice: *Islamic Art*; op cit; p. 77.
[800] Al-Maqqari: *Nafh al-Tibb*; op cit; pp. 84 ff; in A. Chejne: *Muslim Spain,* op cit; p. 365.
[801] Ibid.
[802] D. Talbot Rice: *Islamic Art;* op cit; p. 77.
[803] Ibid; p. 79.

copper.[804] It is, however, the stunning effect of the interior lighting of the Mosque, which is well captured by Scott.[805] This interior, by reason of its vast extent and its comparatively low ceiling, was more or less obscure, even at noon-day, and lamps were kept constantly burning by its aisles; two hundred and eighty chandeliers of brass and silver suspended from its arches, the oil used in them being perfumed with costly essences; the largest of these containing 1454 lamps, and measuring 38 feet in circumference; and its reflector containing 36,000 pieces of silver fastened with rivets of gold. Beauty was enhanced by the gems, and by the combined effect of the mirrors, the light was increased, thus, to nine times its original intensity. During the entire month of Ramadhan the mosque was illuminated with twenty thousand lights. An enormous taper, weighing sixty pounds, was placed in the Maksurah. Its dimensions were calculated with such accuracy that the wax was completely consumed during the last hour of the last day of the festival.[806]
The intensity of light due to the great number of lamps used is no exaggeration, or unique. Artz speaks of the Mosque of Damascus being lit by thousands of hanging lamps of metal and of enamelled glass.[807]

The Muslim impact on subsequent Western construction techniques is a vast subject only touched upon succinctly here. The Cordova mosque, just referred to, had a great impact on the architecture of the Christian Churches.[808] One particular area of impact is the horse shoe arch, which Artz notes was first used by Muslims in the construction of the Mosque of Damascus, hence a very early innovation, which they spread widely as they did with pointed arches.[809] Citing Harvey, the architectural historian, Cochrane explains how it was in Anatolia that skilled masons used techniques subsequently employed by the Crusaders in their own buildings, sometimes by using local workmen they brought with them back to Europe. Cochrane refers to the use of pointed arches by the Seljuk Turks to repair bridges affected by an earthquake in the year 1114, which soon became familiar in the West.[810] Briggs outlines further influences on subsequent

[804] Al-Maqqari: *Nafh al-Tibb*; op cit; pp. 67; 84; 89; in A. Chejne: *Muslim Spain*; op cit; p. 365
[805] S.P. Scott: *History*; op cit; vol 1; p. 663.
[806] Ibid.
[807] F. Artz: *The Mind;* op cit; p.148.
[808] Gomez Moreno: *Iglesias mozarabes* (Madrid; 1919), see also Gomez Moreno: El arte islamico en Espana y en el Magreb; vol 5 of *Historia del Arte* (Madrid, nd).
[809] F. Artz: *The Mind;* op cit; p. 148.
[810] J. Harvey: 'The Origins of Gothic Architecture,' *Antiquaries Journal* 48, 1968, pp 91-4. In L. Cochrane: *Adelard of Bath* (British Museum Press; 1994), pp. 35-6.

developments in the West.[811] He shuns the Church and 'pedantic humanists' of the Renaissance for the blindness to such influence, and cites Islamic influences on constructions in Europe from Sicily to mainland Italy, France, and also England, even on the architecture of Christopher Wren.[812] That influence also extends to military architecture copied from early constructions in Baghdad (8th century,) Salah Eddin's citadel at Cairo, and the citadel of Aleppo (Syria).[813] Influence, which Briggs also traces to the Crusades.[814] Imitation of Muslim skills, Lambert also explains, has often been such that in the Spanish Romanesque, even exteriors of building were done following the Muslim model, such as can be seen near Barcelona on the side of the Catalan church of San Cugat del Valles. This square tower is crowned with the same top as if to evoke a Spanish Muslim minaret of the prototype built in the 10th century in Cordova under Abd Errahman III.[815] Lambert insists that during the Romanesque era, architects and decorators from France and Spain certainly borrowed heavily a great number of forms whether directly or indirectly from Oriental forms, which they imitated with great freedom, transposing them, often in a different spirit from that which has inspired them.[816] And the same happened during the Spanish Gothic era of later centuries.[817]

Muslim masons were widely used in Christian parts, especially following Christian military victories and conquest of former Islamic territory. An early instance is the capture of Barbastro in the north-east of Spain in 1064. An army of Normans and Frenchmen, with the blessing of the Pope and under the command of William VIII, Duke of Aquitaine, took many Muslim prisoners, sending several thousand to France, 1500 to Rome and 7000 to Constantinople.[818] Singers, musicians and other artists were included, but also the Muslim corps of engineers which had defended Barbastro.[819] The spoils of war included a substantial number of craftsmen who possessed a degree of technical skill hitherto unknown north of the Alps and Pyrenees.[820] Subsequently, Muslim architects from Grenada were

[811] M. S. Briggs: Architecture, in *The Legacy of Islam,* edited by T. Arnold and A. Guillaume (Oxford University Press, first edition, 1931), pp 155-79.
[812] Ibid; pp 167-8.
[813] Ibid.
[814] Ibid; p. 179.
[815] E. Lambert: L'Art Hispano Mauresque et l'Art Romant; *Hesperis*; 17; pp. 29-43; at pp. 38-9.
[816] Ibid; p. 43.
[817] Ibid; p. 43.
[818] J. Harvey: The Development of Architecture, op cit; p. 86.
[819] Ibid.
[820] Ibid.

employed by Castilian monarchs in the construction of palaces, and even by orthodox prelates in the ornamentation of cathedrals.[821]

Contacts between Normans and Muslims also go far towards explaining the ambitious architectural programme which became manifest in northern France and in England shortly before, and in the generation succeeding, the Norman Conquest of 1066.[822]

[821] S.P. Scott: *History*; op cit; vol 2; p. 222.
[822] Ibid.

Three

THE GARDENS OF ISLAM

Throughout the Islamic world there prevails today an excessive passion for concrete only matched by an equally strong contempt for greenery. Everywhere the observer is struck by the sight of greenery in fast retreat; forests devastated for commercial purposes, or for no purpose at all; orchards uprooted for urban expansion; gardens and green areas left to abandonment, vandalised, often depository of urban waste; and so on. Also common amongst the Muslim communities settled in the West is to make the concreting of their garden their first deed on the purchase of a new house. Muslim streets are, in fact, easily recognisable in most urban places, thoroughly concreted, no greenery to be seen. Somehow, the impression left to any neutral observer by this is that Islam is fundamentally hostile to greenery, and the colour of its flag, green, has been usurped.

Nothing, though, could be further from the truth, as will be seen in this chapter. And nothing highlights Islam's love for greenery than this instance from early Islamic history noted by Harvey. During the first Muslim military campaigns, Harvey notes, Abu Bekr, the first Caliph (632-634), in setting the war machine in motion, gave the order that no palm trees were to be destroyed, no cornfields burnt, no orchards cut down.[823] Unlike the Greeks, who ravaged the fields of the fellow Greeks with whom they were at war, cutting down their olive groves, the Muslims were at pains to avoid destruction and, as soon as possible, restored peaceful government and prosperity to the countries they overran.[824]

Today's Muslim twin passion for concrete and hate for greenery is a new phenomenon in Islamic society. Without elaborating on this too much, this could be due to the fact that today's Muslim ruling elites, one country or

[823] J. Harvey: *Medieval Gardens* (B.T. Batsford Ltd; London; 1981), p. 37.
[824] Ibid.

two excepted, so obsessed with all aspects of the material, and devoid of any sort of vision that deviates from the crude or vile, have an excessive passion for concrete and an absolute contempt for all things naturally beautiful. This attitude, of course, they force upon their people, just as they force other deviant practices, via the media, education and so on. De-Islamising Muslim society by these elites, previous colonising powers, and other forces, has had its effect, too. The violence inflicted by invaders: crusaders, Mongols, Timur, and Western colonial powers, and subsequent, secular, Westernised elites in power has forced Muslims to deviate considerably from their former antecedents and deeds whether with regard to respect for water as a scarce resource, love for sciences, gardens, environment etc, in order to survive. De-Islamising society has destroyed from within Muslims and Muslim society what was intrinsic to Muslims: extreme precision, order, cleanliness of streets and cities, etc. All these have been suppressed in the course of history, and by force. The instance highlighted in the preceding section of how Muslims were forced to de-bath, that is to destroy their baths, has been generalised to all other aspects of Islam. The brutal colonial occupation, and loss of fertile lands to colonisation, has forced Muslims to turn into deforesters par excellence, a remarkable instance seen in Algeria, in particular, following the French colonisation. From great preservers of greenery prior to the French occupation, the Algerians turned into the greatest deforesters of all after 132 years of French presence.[825] The trauma caused by Mongols, crusaders, occupation, etc…has ended in killing many early noble features of Muslim society, such as the love for books. In Baghdad in 1258, in Aleppo in 1398, when it was taken by Timur the Lame, the massacre of people and the destruction of books were, indeed, equally violent in tenor.[826] And the same in Spain, courtesy to the Church, which had Muslim books burnt in mass auto da fe.[827] Somehow in the Muslim psyche, books and loss of life became very much associated. Never would Muslim society have the same love for books as it did in the early centuries of Islam.

[825] See, for instance:
-C.R. Ageron: *Histoire de l'Algerie contemporaine*, 3 vols (Presses Universitaires de France, 1979).
-C.A. Julien: *Histoire de l'Algerie Contemporaine* (Presses Universitaires de France, 1964).
-H Alleg et al: *La Guerre d'Algerie* (Temps Actuels, Paris, 1981).
[826] See:
E. Gibbon: *The Decline and Fall of the Roman Empire*; vol 6.
J. Glubb: *A Short History*; op cit.
[827] H. C. Lea: *The Moriscos of Spain* (Burt Franklin, New York; 1901; 1968 reprint).

These shifts in the Muslim psyche and attitude relate to every aspect of Islamic civilisation, including gardens and gardening, for indeed, the barrenness and hostility to greenery common amongst most Muslim societies today is in very sharp contrast to what prevailed in early Islam, a love, a passion for gardening, mixed with the art of gardening.

1. Early Islamic Passion for Gardens and Gardening and its Source:

In the words of garden historians, the inhabitants of the early Islamic world were, to a degree that is difficult to comprehend today, 'enchanted by greenery'.[828] In 'a civilisation, which thought of itself as a garden, gardening was naturally an esteemed art,' notes Armesto.[829]

> 'In a mountain of lush greenery,' [says Marcais,] 'Nature finds its home. Here, no place for vegetal mosaics laid on the ground as in Europe, but pieces of orchards where fruit trees and ornamental plants cohabit in a sort of green disorder where ease and abundance prevail. Trees of almonds, pomegranates, peaches, cherries, oranges, lemons, entangle their branches in the middle where rises the darker obelisk of a cypress tree. Nearly always, there can be heard the sound of wings because here birds find sanctuary. They are never disturbed; they can eat the fruit, or drink the water; they are part of the decor.'[830]

Scott describes how the Muslims:

> 'Introduced on a diminished scale the hanging gardens of Babylon. In floral ornamentation they had no superiors. They contrived labyrinths, artificial grottoes, concealed fountains. They traced texts and inscriptions by means of gorgeous blossoms on a ground of living emerald. The intricate designs of tapestry were

[828] D. Sourdel: Baghdad: Capitale du Nouvel empire Abbaside; *Arabica* ix (1962; pp. 251-65. D. Goitein: A Mediterranean Society; op cit; J. Sourdel Thomine: *La Civilisation de l'Islam* (Paris; 1968), J. Dickie: Nosta Sobre la jardineria arabe en la espana Musulmane; *Miscelanea de estudios arabes y hebraicos* XIV-XV (1965-6); pp 75-86. G. Marcais: Les Jardins de l'Islam; in *Melanges d'Histoire et d'archeologie de l'occident Musulman;* 2 Vols (Alger; 1957), pp 233-44;

[829] F.F Armesto: *Millennium;* A Touchstone Publication, (Simon and Shuster New York; 1995), p.35.

[830] G. Marcais: Les Jardins; op cit; p. 240.

> imitated by an infinite variety of flowering plants, whose tints blended in perfect harmony, like the colours of the material they were intended to represent. They acquired such dexterity in the culture of roses that, at all seasons of the year, they bloomed in profusion in every garden.'[831]

From the far eastern parts, on the frontiers with China, to its western shores on the Atlantic, the land of Islam was united in greenery. 'Long indeed would be the list of early Islamic cities which could boast huge expanses of gardens,' Watson holds.[832] Every city had its countless gardens, and on the outskirts were great orchards full of orange and lemon trees, apples, pomegranates, and cherries.[833] In the 10th century, Bukhara consisted of a walled city measuring a league in every direction, and was surrounded by towns, palaces and gardens, which were in turn encompassed by a wall that must have been 100 miles in circumference.[834] The land around Bukhara was turned into a veritable garden growing not merely a rich variety of fruits and vegetables, but many flowers.[835] In private gardens, around splashing fountains, roses, water lilies, violets, myrtle, iris, sweet marjoram, lemon and orange trees were grown, some in great quantities as saleable crops, particularly for the manufacture of perfumes.[836] Thirty thousand bottles of the essence of red roses were sent each year to the caliph of Baghdad.[837] About 150 miles upstream of Bukhara, lay the city of Samarkand, for many miles around the city the fertile lands extended, watered by innumerable canals.[838] In Turkey, Ettinghausen says:

> 'Devotion, if not mania' for pretty flowers, was prevalent everywhere, and in their multitude; fondness for tulips in 16th century Turkey, in particular, having a profound influence on Europe.'[839]

Further to the West, Al-Fustat, Old Cairo, with its multi-storey dwellings, had thousands of private gardens, some of great splendour.[840] Cairo also

[831] S. P. Scott: *History;* op cit; vol 2; p. 605.

[832] A. Watson: *Agricultural,* op cit, p.117.

[833] Z. Oldenbourg: *The Crusades*; op cit; p. 476.

[834] D.R. Hill: *A History of Engineering in Classical and Medieval Times* (Croom Helm; 1984), p. 26.

[835] F.R. Cowell: *The Garden as a Fine Art* (Weidenfeld and Nicolson; London; 1978), p. 72.

[836] Ibid.

[837] Ibid.

[838] D.R. Hill: *A History of Engineering*; op cit; p. 26.

[839] R. Ettinghausen: Introduction; in *The Islamic Garden*, Ed by E.B. MacDougall and R. Ettinghausen (Dumbarton Oaks; Washington; 1976), p.5.

[840] G. Wiet: *Cairo, City of Art and Commerce* (Norman Oklahoma; 1964), pp. 17; 19; 22.

had several garden palaces and many courtyards, and this devotion is in the courtyard tradition in several older private houses that remain to this day.[841] Basra, in Iraq, is described by the early geographers as a veritable Venice, with mile after mile of canals criss-crossing the gardens and orchards;[842] Nisbin, also in Iraq was said to have 40,000 gardens of fruit trees, and Damascus 110,000.[843] One Garden in the city of Samarra of the 9th century consisted of 432 acres, 172 of which being gardens with pavilions, halls and basins.[844] In Baghdad, the gardens of the palaces reached down to the Tigris, and from its farther bank the old town looked down from the west with its domes and its palaces.[845] When in the early 10th century two Byzantine ambassadors arrived in Baghdad, they could not conceal their fascination at what they saw:

> 'The New Kiosq is a palace in the midst of two gardens. In the centre was an artificial pond of tin (or lead), round which flows a stream in a conduit, also of tin, that is more lustrous than polished silver.... All around this tank extended a garden with lawns with palm trees... four hundred of them... The entire height of those trees, from top to bottom was carved in teakwood, encircled with gilt copper rings. And all these palms bore full grown dates, which in almost all seasons were ever ripe and did not decay. Round the sides of the garden also were melons... and other kind of fruit.'[846]

Equally stunned by the eastern greenery were the incoming crusaders (1095-1291). Dreesbach notes that the passages from the French literature of the crusading period, which describe the Orient, show that the things which impressed themselves on the minds of historian, chronicler and poet were the richness of gardens and orchards and the fertility of the fields.[847] Thus, William of Tyre's History goes:

> 'The plain of Antioch are full of many rich fields for the raising of wheat and abounding in springs and rivulets.'[848]

[841] J. Lehrman: Gardens; Islam; in T*he Oxford Companion to Gardens*; ed by G. Jellicoe et al (Oxford University Press; 1986), pp. 277-80 at p. 279.
[842] Al-Duri: *Tarikh al-Iraq* (Baghdad; 1948), pp; 26.8.
[843] Yaqut: *Muaajam*; op cit; vol iv; p. 787.
[844] In R. Ettinghausen: Introduction; op cit; p. 3.
[845] M.L. Gothein: *A History of Garden Art* (Hacker Art Books; New York; 1979), pp. 146-8.
[846] E. Herzfeld: Mitteilungen uber die Arbeiten der zweiten Kampagne von Samarra,' *Der Islam* 5 (1914); 198.
[847] Dreesbach: Der Orient; 1901; pp. 24-36. In J.K. Wright: *The Geographical Lore of the Time of the Crusades* (Dover Publications; New York; 1925), p. 238.
[848] Historia; IV; 10; Paulin Pari's edit.; vol I; pp. 134-5 in J. K. Wright: *The Geographical Lore*; p. 239.

And on the neighbourhood of Damascus:

> 'There are great number of trees bearing fruits of all kinds and growing up to the very walls of the city and where everybody has a garden of his own.'[849]

Crossing into North Africa, where Islamic gardens appeared in the 9th century, [850] one learns of a multitude of gardens, surrounding and inside cities such as Tunis, Algiers, Tlemcen, and Marrakech, places which today are not conspicuous for their greenery.[851] Large gardens of the wealthy had flowers selected for their fragrance, as well as fruit and other trees and vegetables, and water for irrigation was often drawn from a well or from a river by water wheel.[852] These gardens were used for pleasure, and occasionally contained a lake, but there were also smaller enclosed gardens or patios, set out formally, in the Islamic courtyard tradition.[853] In Tlemcen, Leo the African marvelled at the cherries without rivals anywhere else. He saw water wells and fountains gushing with fresh, cool waters, and all around vines growing grapes of all colours and extremely delicate flavours, and cherries so plentiful, and figs so delicious he had never seen the like anywhere else he had been, as well as peaches, walnuts, almonds, melons, and many other fruit.[854] Many luxurious country houses surrounded Algiers, and were renowned for their gardens.[855] A visitor once counted 20,000 gardens, and all around the city grew all sorts of fruit trees; great varieties of flowers, and all sorts of plants; abundant fountains, and in these gardens, among the lush greenery, families used to come and find enjoyment and solace.[856] In Tunisia, where once there thrived urbanity and greenery there is today parched desert land; the region between Gafsa and Feriana, today a desert, had in Islamic times about 200 villages.[857] Tunis, according to an early 16th century Turkish observer, had fifty thousand houses, each 'resembling a sultan's palace', and orchards and gardens fringe the city.[858] In each of these gardens, were villas and kiosks, pools

[849] Historia; XVII, 3; Paulin Pari's edit.; vol ii; p. 141 in J. K. Wright: *The Geographical Lore*; p. 239.
[850] J. Lehrman: Gardens; Islam; op cit; p. 279.
[851] Torres Balbas: La Ruinas de Belyunes o Bullones; *Hesperis Tamuda* v (1957) 275-96; 275 ff; G. Marcais: les Jardins de l'Islam; op cit.
[852] J. Lehrman: Gardens; op cit; p. 279.
[853] Ibid.
[854] Leon The African in G. Marcais: les Jardins; op cit; p. 241.
[855] J. Lehrman: Gardens; Islam; op cit; p. 279.
[856] In G. Marcais: Les Jardins; op cit; p. 241.
[857] A. Solignac; p. 382; in A.M. Watson: A Medieval Green Revolution; op cit; Note 44; p. 56.
[858] S. Soucek: Tunisia in the Kitab-I Bahriye of Piri Reis, *Archivum Ottomanicum*, Vol 5, pp 129-296. p. 197.

and fountains, and the scent of jasmine overpowering the air. There were water wheels, too, and such an abundance of fruit people hardly paid any attention to them.[859]

In Spain, writers speak endlessly of the gardens and *lieux de plaisance* of Seville, Cordova and Valencia; the suburb of Valencia having so many orchards and flower gardens that the city looked like a maiden in the midst of flowers, the scent of which perfumed the air;[860] the city was called by one writer ''the scent bottle of al-Andalus.'[861] Market gardens, olive groves, and fruit orchards made some areas of Spain-notably around Cordova, Granada, and Valencia-"garden spots of the world."[862] In the 10th century, all the country around Cordoba was one great garden, and according to al-Maqqari, 50,000 villas were set like stars in the firmament in the countryside all around the city.[863] Inside and around the city there were palaces of recreation in the midst of beautiful ornamental gardens.[864] Murcia, according to Al-Maqqari was 'filled with scented flowers, singing birds, and water wheels with rumorous sound.'[865] According to the same author, the banks of the Guadalquevir were decorated with fine buildings and beautiful pleasure gardens.[866] The Island of Majorca, won by the Muslims in the 8th century, became under their husbandry 'a paradise of fruits and flowers, dominated by the date palm that later gave its name to the capital.'[867] The gardens of Almeria extended for a radius of twenty miles north, east, and west from the harbour.[868] The famed pleasure garden of the Nasrid period in Grenada was *Jannat al-Arif* (Sp. Generalife) (The Garden Of The inspector Of The Very High Garden), known for its luxuriant trees and the healthiness of its air.[869]

Like every science, and like every single aspect of Islamic civilisation, behind the passion and devotion to gardens and gardening, natural beauty

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[859] Ibid.
[860] S.M. Imamuddin: *Muslim Spain* (Leiden; E. J. Brill; 1981), p.85.
[861] Al-Maqqari: *Nafh al-Tib;* op cit; vol I; p.67; H. Peres: *La Poesie Andaluse en Arabe Classique au Xiem siecle* (Paris; 1953), pp. 115ff.
[862] W. Durant: *The Age of Faith*; op cit; p. 298.
[863] Al-Maqqari in E. Hyams: *A History of Gardens and Gardening* (J.M. Dent and Sons LTD; London; 1971); p. 82.
[864] Al-Maqqari: *Nafh al-Tib*; op cit; pp. 211-2.
[865] J. Harvey: *Medieval Gardens;* op cit; p. 38.
[866] Al-Maqqari: *Nafh al-Tib*; vol I; I; pp. 57-8.
[867] W. Durant: *The Age of Faith*; op cit; p. 298.
[868] S.P. Scott: *History*; op cit; vol 2; 614.
[869] Al-Maqqari: *Nafh al-Tib*; II; p. 360; n. 12.

and greenery, was the faith, Islam, and its central element, the Qur'an. Thus, we read in the Qur'an:

> 'Surely the God fearing shall be among gardens and fountains.' (Qur'an 51/15).
> 'And those on the right hand; what of those on the right hand?
> Among thornless lote trees
> And clustered plantains,
> And spreading shade,
> And water gushing,
> And fruit in plenty
> Neither out of reach nor yet forbidden,
> And raised couches.' (Qur'an 56/27-34)

And equally:

> 'But for him who feareth the standing before his Lord there are two gardens.
> Which is it, of the favours of your Lord, that ye deny?
> Of spreading branches.
> Which is it, of the favours of your Lord, that ye deny?
> Wherein are two fountains flowing.
> Which is it, of the favours of your Lord, that ye deny?
> Wherein is every kind of fruit in pairs.
> Which is it, of the favours of your Lord, that ye deny?
> Reclining upon couches lined with silk brocade, the fruit of both gardens near to hand.
> Which is it, of the favours of your Lord, that ye deny?
> Therein are those of modest gaze, whom neither man no jinni will have touched before them.
> Which is it, of the favours of your Lord, that ye deny?
> (In beauty) like the jacinth and the coral stone.
> Which is it, of the favours of your Lord, that ye deny?
> Is the reward of goodness aught save goodness?
> Which is it, of the favours of your Lord, that ye deny?
> And beside them are two other gardens.
> Which is it, of the favours of your Lord, that ye deny?
> Dark green with foliage.
> Which is it, of the favours of your Lord, that ye deny?
> Wherein are two abundant springs.
> Which is it, of the favours of your Lord, that ye deny?
> Wherein is fruit, the date palm and pomegranate
> Which is it, of the favours of your Lord, that ye deny?
> Wherein (are found) the good and the beautiful-
> Which is it, of the favours of your Lord, that ye deny?

Fair ones, close guarded in pavilions-
Which is it, of the favours of your Lord, that ye deny?
Whom neither man nor jinni will have touched before them-
Which is it, of the favours of your Lord, that ye deny?
Reclining on green cushions and fair carpets.
Which is it, of the favours of your Lord, that ye deny?
Blessed be the name of thy Lord, Mighty and Glorious.'
(Qur'an LV: 46-78).

The expression: 'Gardens underneath which rivers flow' is the most repeated expression in the Qur'an (thirty seven times) for 'the bliss of the faithful.'[870] Picturesque as the Qura'nic descriptions of the heavenly garden may be,' Shimmel holds, 'we can only imagine what it may be like.' Sura 57/21 specifies its extension:

> 'And a Garden the breadth whereof is as the breadth of heaven and earth…'

and sura (77/41):

> '…Shades and fountains and such fruits as their hearts desire.'

Descriptions of the heavenly garden, which Schimmel explains, are consistent and give an impression of greenery and gushing fountains.[871]

Faith and greenery also predominate in the words of poets, here the Egyptian Dhu'n-Nun (d.859):

> 'O God, I never hearken to the voices of the beasts or the rustle of the trees, the splashing of the waters or the song of the birds, the whistling of the winds or the rumble of the thunder, but I sense in them as testimony to Thy Unity, and a proof of Thy incomparableness, that Thou art the All Prevailing, the All Knowing, the All True.'[872]

Yunus Emre, the medieval mystic of Anatolia, in a little poem, describes Paradise in these simple words:

'Sol cennetin irmaklari
Akar Allah deyu deyu…..
The rivers all in paradise
Flow with the word Allah, Allah,
And every longing nightingale
He sings and sings Allah, Allah;

[870] A.Schimmel: The Celestial garden in Islam; in *The Islamic Garden*, op cit; pp 13-39; at p. 15.
[871] Ibid; p. 17.
[872] Ibid; p. 24.

The branches of the Tuba tree
The tongue reciting the Qur'an,
The roses there in Paradise,
Their fragrance is Allah, Allah…'[873]

Garden historians were prompt to see such connections between faith and the early Islamic passion for gardening.[874] When a whole people can anticipate the paradise of afterlife as a garden, there can be little doubt about their enthusiasm for gardens on aesthetic grounds and still less doubt about their high significance in the every day life of those times, says Cowell.[875] Ettinghausen, too, notes that:

> 'If the garden was such a ubiquitous art form in the Muslim world, being both socially and geographically extensive, there must have been specific reasons for this propensity…' and first comes 'the idea of Paradise as a reward for the Muslim faithful,' a garden, descriptions of which have 'played an important part in the Muslim cosmography and religious belief.'[876]

Early Muslims everywhere, Watson holds, 'made earthly gardens that gave glimpses of the heavenly garden to come.'[877] Every garden was meant to be a little paradise as Ettinghausen put it 'for the happy owner' carefully protected from the hustle and bustle of the city and its odours.[878] The spread of Islam saw many gardens established, since not only did they provide climatic relief in those parts of the world, but they granted foretaste of the reward promised to the faithful, as well as a less spiritual but attractive reflection of the traditional royal-pleasure garden.[879] And the earthly visions of Paradise have inspired the construction of gardens; rivers flowing through paradise helping architects to conceive the canals as they flow through the gardens, each part of the garden being in some way a similitude of Paradise.[880]

Literary and archaeological sources find origins of gardens as early as the 730s, and stretching to the whole Islamic world.[881] In laying out and

[873] *Yunus Emre Diwani;* ed A. Goplinarli (Istanbul; 1943), Nr. 477.
[874] G. Marcais: Les Jardins; op cit; J. Dickie: Nosta Sobre la jardineria arabe en la espana Musulmane; *Miscelanea de estudios arabes y hebraicos* XIV-XV (1965-6); pp 75-86.
[875] F.R. Cowell: *The Garden as a Fine Art* (Weidenfeld and Nicolson; London; 1978), p. 75.
[876] R. Ettinghausen: Introduction, op cit, at p. 6.
[877] A.M. Watson: *Agricultural;* op cit; p.117.
[878] R. Ettinghausen: Introduction; op cit; p. 7.
[879] J. Lehrman: Gardens; Islam; op cit; p. 278.
[880] A.Schimmel: The Celestial, op cit; p. 15.
[881] R. Ettinghausen: Introduction; op cit; p. 3.

ornamenting gardens, kings and nobles, rich and poor, theologians and laymen, all participated with equal zeal and enthusiasm and, as a result, each villa, each palace and each town was a delight to the eye.[882] Rulers in the days of Islam, when not versed into scholarly passion, were equally passionate about their gardens; they and their surrounding elites laying out their beautiful gardens in palaces for recreation both on river bank and in mountain valleys and on mountain tops, supplying them with water in abundance.[883] Some such gardens had great splendour, and their renown went beyond their territory, such as al-Mu'tasim's gardens at Samarra, Iraq;[884] the great royal parks of the Aghlabid emirs of Tunisia, near Al-Qayrawan, the famous garden of the Hafsid rulers, also in Tunisia;[885] and the gardens surrounding the royal palaces at Fez and Marrakech.[886] In Cairo the Mamluk sultan Qalawun (Qala'un) introduced Syrian plants into his garden in great variety,[887] whilst Rumarawayh, a Tulunid ruler in the later 9th century, had in his garden palm trees, whose trunks were covered with gold; behind this covering were pipes which brought water up the side of the trees and sprayed it out from various openings into pools.[888] In the Yemen, a number of 14th century sultans became so seriously interested in botanical and agricultural research, one of them wrote an agricultural treatise whilst another specialised in adapting exotic trees from distant places.[889] The Spanish Caliphs, as they did with rare manuscripts, sought plants and seeds of rare species from the furthest places, and with equal determination. Abd Errahman I was so passionately fond of flowers and plants, he sent agents to Syria and other parts of the East to procure new plants and seeds.[890] He planted a beautiful garden in imitation of the Rusafah Villa of Damascus.[891] By the 10th century, the royal gardens at Cordova became botanical gardens, with fields for

[882] S.M. Imamuddin: *Muslim Spain;* op cit; p.85.
[883] Ibid.
[884] H. Viollet: Description du Palais de al-Mutassim a Samarra; in *Memoires de l'Academie des Inscriptions et des Belles Lettres*; XII : 1913.
[885] A. Solignac: Recherches sur les installations hydrauliques de kairaouan et des Steppes Tunisiennes du VII au Xiem siecle, in *Annales de l'Institut des Etudes Orientales*, Algiers, X (1952); 5-273. pp 218 ff; G. Marcais: Les Jardins; op cit; p. 237.
[886] G. Marcais: Les Jardins; op cit; p. 237.
[887] Al-Maqrizi, Ahmad Ibn Ali. *Al-Mawaiz wa Alitibar fi dhikr al-Khitat wa-Al-athar*. Edited by Ahmed Ali al-Mulaiji. 3 Vols, (Beirut: Dar al Urfan. 1959), II; op cit; p. 119.
[888] Ibid; 96.
[889] M. Meyerhof: Sur un traite d'agriculture compose par un sultan Yemenite du XIV em siecle; *Bulletin de l'Institut d'Egypte*; xxv (1942-3) 54-63; xxvi (1943-4); 51-64; (1942-3) p.58; and (1943-4) pp. 52; 57.
[890] A. Watson: *Agricultural,* op cit, p.118.
[891] S.M. Imamuddin: *Some Aspects of the Socio-Economic and Cultural History of Muslim Spain* (Brill; 1965), p. 82.

experimentation with seeds, cuttings and roots brought in from the outermost reaches of the world.[892] Other royal gardens, in Spain and elsewhere, also became the sites of serious scientific activity as well as places of amusement. A recently discovered manuscript by al-Udhri informs us that al-Mu'tasim, a Taifa king (11th century), brought many rare plants to his garden in Almeria, which even included banana and sugar cane.[893]

This passion for gardening extended to the population at large, the Muslims using the art of planting to beautify their homes and countryside.[894] Ettinghausen notes how there were even carefully planned mini gardens with trees, bushes, flowers and central water basins and fountains in the courtyards of countless private homes, owned by men of very limited means.[895] At Fustat, in old Cairo, multi storey houses were all perfumed with private gardens, and interior courtyards all had their water basins and squares where flowers blossomed.[896] A visitor to Tunis in 1470, wrote that every citizen had his garden, agreeably pervaded by perfumes from great varieties of flowers, and all sorts of fruit trees; and fountains rising in the middle.[897] In Spain, Scott writes:

> 'Love of flowers was a veritable passion among the Spanish Moslems. As they were the greatest botanists in the world, so no other nation approached them in the perfection of their floriculture and the ardour with which they pursued it. The profusion and variety of blossoms of every description were marvellous and enchanting; each had a meaning, by which tender sentiments could be conveyed without the instrumentality of speech; they were associated with every public ceremony and with the most prosaic occurrences of domestic life; they dispensed their fragrance from the priceless vase of the palace; they covered the cottage of the labourer; they formed the daily decoration of the luxuriant tresses of the princess and the peasant; their garlands were the common playthings of the infant.'[898]

[892] Al-Maqqari: *Nafh al-Tib;* ii: 14-5; H.Peres: Le Palmier en Espagne Musulmane; In *Melanges Geodefroy Demombynes* (Cairo; 1935-45), pp. 224-39.
[893] Al-Udhri: *Nusus an al-Andalus*; ed. Abd al-Aziz al-Ahwani (Madrid; 1965), p. 85.
[894] S.M. Imamuddin: *Some Aspects*; op cit; p. 82.
[895] R.Ettinghausen: The Islamic; op cit; p.5.
[896] G. Marcais: Les Jardins; op cit; p. 236.
[897] Brunschvig, quoted in G. Marcais: Les Jardins; op cit; p. 242.
[898] S.P. Scott: *History,* op cit, vol 2; p.651.

Amidst greenery was also found genial creativity. The Muslims, Gothein says, liked artificial culture, different fruits on one tree; different grapes on one vine, which they thought specially pleasing, and they liked to have flowers of unnatural colours, and to graft a rose upon an almond tree.[899] In the Tulunid garden (9th century Egypt), they planted saffron and other plants; the gardeners cut plants into various figures, as well as the shapes of letters, and this had to be kept regular, lest a single leaf should stick out.[900] A tower was made in open work teak to serve as a bird cage, painted in many colours, with paved floors, and little streams purling.[901] The garden, plants, and animals were all watered with well sweeps, the birds, which filled this house with their sweet songs, not only found baths and food there, but also their nests, in pretty coloured pots prepared for them and let into the walls.[902] There were also peacocks and fowls, and various wild creatures in great numbers running loose.[903] At his castle in Baghdad, Caliph al-Qahir had a garden laid out in a court, only a third of an acre in size, but it contained orange trees brought from Basra, Oman and India, and on the regularly planted trees there gleamed yellow and red fruit, bright as the stars of heaven against the dusky foliage.[904] Around grew all kinds of shrubs, sweet smelling flowers, and plants, and many birds were there: turtle doves, ouzels, and parrots, brought from foreign lands and distant towns.[905] Fruit trees provided cool shade against the intense heat, flowers supplied fragrance and colour, terraces and canals assisted horticulture and irrigation, while cascades, pools, and fountains cooled and moistened the air, providing gentle sound and visual delight.[906]

The garden, a symbol of the promised paradise, has, thus, become a little earthly paradise in itself. For the early Muslim, lengthy contemplation of such beauty was enough to replenish life and chase away its sorrows and stresses. An owner would take delight in his garden more by sitting on a rug and cushions in contemplation of his pavilion, than by walking through it.[907] In front of his palace Rumarawayh, the Tulunid ruler of Egypt (r. 884-896), built a pool of 50x50 cubits filled with mercury on which he floated on an air mattress to cure his insomnia; it was reported to be spectacular

[899] M.L. Gothein: *A History of Garden Art* (Hacker Art Books; New York; 1979), p. 150.
[900] Ibid.
[901] Ibid.
[902] Ibid.
[903] Ibid.
[904] Ibid; p. 151.
[905] Ibid.
[906] J. Lehrman: Gardens; Islam; op cit; p. 278.
[907] Ibid.

by moonlight. And to enjoy his view, Rumarawayh even built a domed kiosk in his palace overlooking the bustan (garden) and the city.[908] There, inside his artificial Spanish paradise-the site of Soto de Rojas famous poem[909] could have been chosen by an Arab-he could enjoy in solitude the voluptuous pleasure produced by different perfumes, colours and shapes in endlessly varied combinations: in sum, it was a place where the refined sensuality of the Muslim sensibility could find full and perfect expression, says Dickie.[910] 'It is from this quiet scene of beauty found in the Arabian court garden,' Gothein concludes, 'that their poetry takes its beginning.'[911]

2. The Islamic Garden:

Abu Uthman Ibn Luyun al-Tujibi of Almeria (1282-1349) composed in 1348 within the last years of his life a poem in simple verse,[912] which has been known to the outside world as the 'Andalusian Georgics.' It is in fact a masterpiece of compression, scientifically abbreviated from the best earlier sources, Muslims and non Muslim.[913] Sections on soils, water and levelling, manures and labours such as ploughing are followed by a detailed treatise on propagation of all kind and of the various categories of plants.[914] In all more than 150 species are named, over 30 of them grown for the beauty of their flowers or for their scent. Somewhat unusually for a work in verse, this is fully referenced in over 350 notes directing to the sources.[915] Ibn Luyun, thus, designs for us the garden:

> 'With regard to houses set amidst gardens and elevated site is to be recommended, both for reasons of vigilance and of layout;
> and let them have a southern aspect, with the entrance at one side, and on an upper level the cistern and well,

[908] Doris Behrens-Abuseif: Gardens in Islamic Egypt: *Der Islam* Vol 69 (1992); pp 302-312; at p. 304:
[909] *Parayso cerrado para muchos, jardines abiertos para pocos* 'Paradise closed to many, gardens open to few.'
[910] J. Dickie: The Islamic Garden; op cit; in *The Islamic Garden* (Ed by E.B. MacDougall and R. Ettinghausen) op cit; pp. 87-106; p. 105.
[911] M.L. Gothein: *A History of Garden Art*; op cit; p. 151.
[912] J. Eguaras Ibanes: *Ibn Luyun: Tratado de Agricultura* (Granada; 1975), review in *Garden History*; V; No 2 (1977); pp. 6-8.
[913] J. Harvey: *Medieval Gardens;* op cit; p. 44.
[914] Ibid.
[915] Ibid.

or instead of a well have a watercourse where the water runs underneath the shade.
And if the house have two doors, greater will be the security it enjoys and easier the repose of its occupant.
Then next to the reservoir plant shrubs whose leaves to not fall and which rejoice the sight;
And, somewhat further off, arrange flowers of different kinds, and, further off still, evergreen trees,
And around the perimeter climbing vines, and in the centre of the whole enclosure a sufficiency of vines;
And under climbing vines let there be paths which surround the garden to serve as margin.
And amongst the fruit trees include the grapevine similar to a slim woman, or wood producing trees;
Afterward arrange the virgin soil for planting whatever you wish should prosper.
In the background let there be trees like the fig or any other which does no harm;
And plant any fruit tree which grows big in a confining basin so that its mature growth may serve as a protection against the north wind without preventing the sun from reaching [the plants].
In the centre of the garden let there be a pavilion in which to sit, and with vistas on all sides,
but of such a form that no one approaching could overhear the conversation within and whereupon none could approach undetected.
Clinging to it there be roses and myrtle, likewise all manners of plants with which a garden is adorned.
And this last should be longer than it is wide in order that the beholder's gaze may expand in contemplation.'[916]

The shape of the Islamic garden, Lehrman informs us 'was nearly always rectangular. It was surrounded by a wall, and an elaborate gateway gave on to a main axis often formed by a water course with one or more subsidiary axes at right angles. Channels and pools were flanked by paths and terraces, often bordered by defined areas of flowers and shrubs with trees for shade; this planting softened the man made geometry. With a pavilion or other form of building in the centre, all vistas were precisely terminated by a further

[916] Ibn Luyyun: *Kitab ibda' al-Malaha wa-inha al-rajal fi usul sina'at al-Filaha;* in Lerchundi and Simonet; Gestomatia arabigo Espanola (Grenada; 1881); p. 136; in J. Dickie: The Islamic Garden; op cit; p. 94.

pavilion, gateway, or vaulted recess. Paths were always straight and paved with bricks, stone, pebbles, or mosaic. Although the use of geometry was universal across the Islamic world, there is always a strong sense of place in the garden, with remarkable little uniformity. When sited on a gradient the garden was terraced. In the large royal gardens, especially in India, the public was received only on the lower terrace. The central terrace was private and used for formal audience; the upper terrace was reserved for women. At changes of level, water fell over cascades of carved chutes. On flat sites, channels were given a slight gradient to ensure a flow. Water in pools and channels was always contained in a precise manner.'[917]
Hyams adds to this overall description, that 'The beds for trees and evergreen or flowering shrubs were sunk below the level of the paths, which were always paved, pebbled or covered with mosaic. Where any flowers at all were grown, they were planted in large earthenware pots or vases. Lawns were unknown; some gardens were paved all over except rectangular beds left uncovered for planting. Walls, balustrades, seats, the sides of fountains and all such vertical surfaces were apt to be covered with brightly coloured tiles, a practice which can be best seen today in some old Portuguese gardens such as that of the Pena palace. There were, of course, no statues in Islamic gardens, since the Qur'an forbids the making of graven images.'[918]

The courtyard and courtyard garden in Islam, and especially the Islamic garden itself, were seen to reflect both human biological and physiological needs as well as the Islamic religious principle of unity and order.[919] Design reflected both the rational and spiritual nature of the human and was expressed in a remarkable unity of concept that was reflected in gardens from southern Spain to north West India, and common to all was the same sense of order, focus on water, and spirit of serenity, yet, each site was unique, and the geometry introduced served only to enhance the genius loci.[920]
Within this sense of order, paths of Islamic gardens were never random or winding, always leading straight to some goal, perhaps a pavilion; sometimes to a view through an ornamental unglazed window in the outer wall; often to an arbour or kiosk made of wood or stone or bricks, brightly tiled, with vines trained over it. The last feature was to become known in later Spanish gardens as a glorietta.[921] The name gloriet comes from the

[917] J. Lehrman: Gardens; Islam; op cit; p. 278.
[918] E. Hyams: *A History of Gardens and Gardening* (J.M. Dent and Sons LTD; London; 1971), p. 84.
[919] J. Lehrman: Gardens; Islam; op cit; p. 278.
[920] Ibid.
[921] E. Hyams: *A History of Gardens*; op cit; p. 84.

Spanish glorieta, a translation of the Arabic *'aziz*, still surviving at the palace of la Ziza in the royal gardens at Palermo, where an inscription reads: 'Here is the earthly paradise… this is called al-'aziz (the Glorious).'[922] This resembles the subsequent greater gardens of medieval France and Britain, the plan with a central pavilion or gloriet, surrounded by flowers, by rows of trees, and by pergola arbours covered with vines on trellis.[923]

The search for privacy, common to other aspects of Islamic life, was also found in the garden. The garden provided a calm and harmonious retreat from the noisy, turbulent and dusty world outside. The Islamic garden was therefore always enclosed, private, and protected.[924] The differences in psychology between the Muslim and European are accurately reflected in their respective garden traditions, observes Dickie.[925] The high walls of the Islamic garden prevented its owner being seen from outside and insulated him against the clamour and dirt of the antipathetic life of the streets.[926] According to what can be learnt from excavations, indeed, the favourite kind of garden among the Muslims was the completely enclosed court garden, either shut in the buildings or high walls very like them, and it is only at the great man's palace that the garden set high over the river bank gives the possibility of a fine view and seclusion at the same time.[927] Muslims surrounded their gardens with very high walls and then to double the measure of privacy and degree of shade by planting trees-sometimes fruit trees, but chiefly cypresses-inside the walls.[928]

Closely related to this desire for privacy, the facades of Muslim dwellings were bare, betraying nothing of the luxury within.[929] All were pervaded by intimacy and secrecy; access was gained by a twisting passage so that the splendour of the patio should not be seen until after the second turning.[930] The buildings were simple to the extreme, made of poor quality brick or whitewashed rubblework, but the patios inside, and their secret gardens, undoubtedly contained a profusion of fruit trees and flowers.[931] This is the origin of the popular song:

'Mine is the same condition

[922] J. Harvey: *Medieval Gardens;* op cit; p. 44.
[923] Ibid.
[924] J. Lehrman: Gardens; Islam; op cit; p. 278.
[925] J. Dickie: The Islamic Garden in Spain; op cit; p. 105.
[926] Ibid.
[927] M.L. Gothein: *A History of Garden Art*; p. 151.
[928] E. Hyams: *A History of Gardens*; op cit; p. 84.
[929] Marquesa de Casa Valdes: *Spanish Gardens*; tr E. Tanner (Antique Collectors' Club' Valencia; 1973), p. 27.
[930] Ibid.
[931] Ibid.

As the house of the Moorish king
Outside the plaster is rotting
But treasure lies hidden within.'[932]

The tall, dense and evergreen enclosure was, as always, on a rectilinear plan, and central to it was at least one canal, probably two or three parallel, and possibly a whole grid of canals so that the division of the garden was made by water.[933] Jets of water sprang from the canals and fell into them, but there would be other, more elaborate, fountains as well, often in enclosed or cloistered courts.[934] The most simple place has at least one fine fountain; the paths are very often paved with costly marble and shaded with vines; sometimes the whole court is paved, and in that case the trees are planted in great boxes or in reserve corners where earth has been left.[935] The beds are bordered with stone, and beside the paths are strong scented plants, or clipped shrubs, salvia, myrtle, and bay hedges, and climbing plants hanging from tree to tree.[936] Besides the walls there were fountains and there were water cisterns in the middle; through the doors one had a glimpse of the flower garden, where antelopes were playing about, and in an aviary pigeons flew hither and thither.[937]

A special feature of the Islamic gardens, little remarked upon and never generally adopted elsewhere, was their sunken flower beds.[938] In the medieval Spanish Muslim garden of the Patio de la Aceqia the flower beds were half a metre (18 inches) below the surrounding paths.[939] Dickie points out the advantage of such an arrangement.[940] When the flower blossoms were at feet level, they gave anyone walking on the paths the illusion of treading a floral carpet. At the same time such a design accentuated the geometrical form of the gardens, leaving the architectural features of the adjacent buildings clear and un-obscured by vegetation.[941] In heavy rain, the soil would not be washed on to the path, as happens with raised flower beds.[942] Harvey notes, how, indeed, the Muslim Spanish love of sunk beds

[932] Ibid.
[933] E. Hyams: *A History of Gardens*; op cit; p. 84.
[934] Ibid.
[935] M.L. Gothein: *A History of Garden Art*; op cit; p. 151.
[936] Ibid.
[937] Ibid.
[938] F.R. Cowell: *The Garden as a Fine Art;* op cit; p. 75.
[939] Ibid.
[940] J. Dickie: The Islamic Garden in Spain; op cit; pp. 98 ff.
[941] F.R. Cowell: *The Garden as a Fine Art*; Op cit; p. 75.
[942] Ibid.

beside raised paths, giving the illusion of walking on a carpet formed by the tops of plants-contrasting with northern raised beds, as Gorer suggested, may be due to the climatic need to collect or drain the rainfall.[943]

The Islamic Spanish garden also shared with the rest of Islamic gardens the same attributes of order, geometry, coolness, privacy, and a focus on water.[944] There are no large pools, and a local characteristic of large gardens was their division into small enclosures; paths were often placed above the level of vegetation resulting in an impression of walking at the level of the tops of flowers.[945] Due to hilly terrain, the plans of gardens were slightly irregular, but splendid views were offered. Enclosing walls were of stuccoed masonry, and tiles were used as facing on seats, pools, paths and steps.[946] There was great use of accessories such as benches and pots, although these may be of relatively recent vintage. Ever greens, especially citrus trees, were planted, and flowers were chosen for fragrance, and there was no grass.[947] The Muslim chronicler, Ibn Said, described the houses and gardens built by sultans and Cordoba's caliphs, and those of rich landowners, as can be found in many extracts of al-Maqqari, already cited.[948] This author goes on to describe the many palaces and pleasure gardens on the outskirts of Cordova, in particular, especially the one built by Al-Mansur (d.1002), on the banks of the Guadelquevir, then known as al-Zahira, which possessed a large lake covered with water lilies.[949]

The most famous of the earlier Spanish gardens was that of *Madinat az-Zahra*, also near Cordova, built by Caliph Abd Errahman III (r. 912-961). It was terraced on a hillside, the terraces being built of marble; its rides and walks paved with mosaics.[950] Ibn Hayyan (d.1076), relates that among the marvels, there were two fountains whose basins were of such extraordinary form and so priceless for their exquisite workmanship that, in his opinion, they constituted the principal ornament of the palace.[951] Another of the marvels of Madinat al-Zahra was the Hall of the Caliphs, which, in its centre, according to Ibn Backual, had a pond of porphyry filled with mercury. When the rays of the sun penetrated this apartment the glitter of its walls was

[943] J. Harvey: *Medieval Gardens;* op cit; p. 44.
[944] J. Lehrman: Gardens; Islam; op cit; p. 279.
[945] Ibid.
[946] Ibid.
[947] Ibid.
[948] Al-Maqqari: *Nafh Al-Tib.*; see also Marquesa de Casa Valdes: *Spanish Gardens*; p. 30.
[949] In Al-Maqqari: *Nafh Al-Tib*, op cit; vol 1; p. 243.
[950] E. Hyams: *A History of Gardens*; op cit; p. 82.
[951] In Al-Maqqari: *Nafh Al-Tib*; op cit; vol i; Book iii; chapter iii; p. 236.

dazzling.[952] One can well imagine the astonishment of the rough northern chieftains Sancho of Leon and Garcia of Navarre when they were made to walk the length of this series of salons.[953] Miles of clipped box, bay and myrtle hedges divided the garden into many smaller gardens, all rectilinear as was the rule; irrigation canals fed all parts of the garden and worked hundreds of fountains.[954] On these water works, al-Maqqari comments:

> 'After supplying this palace, and irrigating with profusion every corner of its gardens, notwithstanding their great extent, the superabundant water went to augment the Guadelquevir, Every author we have consulted on the subject agrees in saying that this aqueduct, with the reservoir, and the figure pouring the water into it, must be considered as one of the most amazing structure ever raised by man; for if we attend to the length of it, to the unfavourable nature on the ground through which it was conducted, the magnitude and solidity of the construction, the height of the piers over which the water was made to flow, sometimes ascending, sometimes descending, we shall scarcely find among the works of ancient kings which have reached us anything to be compared to it.'[955]

Grenada, wrested last from the Muslims in 1492, has preserved most of the Islamic Spanish heritage. There are countless descriptions of such Islamic garden legacy in the city, but the most succinct description, and satisfactorily informative, is by Hyams, and is used here.[956] 'Most famed of its Islamic heritage is the Alhambra, started in the 11th century but the finer parts of which were built from 1248 by Al-Ahmar. Of the numerous original patios or courts only four remain, but from them we can get some idea of what the whole garden was like in say, 1400, and until the re-conquest (1492). First, the court of the Myrtle consists chiefly of a long, broad pool enclosed by galleries and a colonnade on the north and south sides and by clipped myrtle which, despite the clipping, flowers deliciously. The much more famous Court of Lions into which it opens through a decorated doorway dates from about 1350, and is surrounded by a peristyle of alabaster columns supporting 'Moorish' arches, with a pavilion at each end of the long axis. The Lion fountain from which the name derives is central and feeds four small channels, in the manner of the channels of the Villa Adriana, which divide the area into parts now gravelled but originally occupied by shaped citrus

[952] Marquesa de Casa Valdes: *Spanish Gardens*; op cit; p. 30.
[953] Marquesa de Casa Valdes: *Spanish Gardens*; op cit; p. 30.
[954] E. Hyams: *A History of Gardens*; op cit; p. 82.
[955] Al-Maqqari: *Nafh Al-Tib.*; in A. Thomson and M. Rahim: *Islam in Andalus* (Taha; London; 1996), p. 63.
[956] E. Hyams: *A History of Gardens*; op cit; p. 85.

tress and possibly by some flowers. The third court, the Court Doraxas, originally for the use of the harem ladies, is contained by walls lined with fine old cypresses and orange trees. Originally they must have been planted regularly, but time has given them a pleasingly scattered or random look. The fountain at the centre looks as if it had been restored in the Renaissance manner and can hardly be called 'Moorish.'[957]

The making of the Generalife began later than the Alhambra but before 1300. It was built as a summer palace for the kings of Grenada. It is on seven levels, the site being a hillside. The highest terrace is the Court of the Canal, which is enclosed on three sides by buildings and on the fourth by an arcade, its name being derived from the narrow canal down the centre of the long axis. Other features of this court are a miniature mosque, a fountain, and clipped box parterres. At a lower level on one side is a square walled garden, the walls pierced by decorated windows commanding fine views. On the other side is the Harem court with a horse shaped canal, ancient cypresses, and oleanders, leading to the next terrace through an arched gateway by way of steps and landings ornamented with pebble mosaics. A belvedere reached by more decorated steps is above this terrace, and from it there is a novel water staircase, the water being carried down the hollow tiled balustrade. Stairs lead to the Mirador from which you have a view of the Alhambra, with the sierra in the distance.[958]

3. The Place of Water:

Water played the most significant role in Islamic gardens just as it did in every aspect of early Islamic society. Early Muslims (8th-13th centuries) developed a whole legal system around water, even water tribunals.[959] This particular matter will be highlighted in the chapter on agriculture. The importance of water is further highlighted by the fact that all of Muslim treatises on agriculture, whether Maghribi, Andalusian, Egyptian, Iraqi, Persian or Yemenite, Bolens points out, insist meticulously on the deployment of equipment and on the control of water.[960] A whole science

[957] Ibid.
[958] Ibid.
[959] S.P. Scott: *History*; op cit; vol 3; pp 602-3.
[960] L. Bolens: L'Eau et l'Irrigation d'apres les traites d'agronomie Andalus au Moyen Age (XI-XIIem siecles), *Options Mediterraneenes*, 16 (Dec, 1972)., p. 451.

also grew around water, and nearly all sciences evolved around this resource. The engineers, whether Al-Jazari, or the Banu Musa, who will be looked at in great length further on, built machines and mechanisms all related to water; Al-Zarqali built his complex Toledo Clock also around water; Qaysar the Syrian built huge water wheels on the Orontes; and water wheels and water power drove Islamic factories and mills.[961] Civil engineers excelled at dam construction, some dams in parts of Spain still working to this day, nearly twelve centuries after they were completed.[962] In Tunisia, one of the most endearing engineering accomplishments is the Basin of the Aghlabids, an ensemble of reservoirs near Al-Qayrawan dating from the 9th century.[963] Geographers and travellers of Islam all focused their minds on water and all that was related to it. So did historians of Islam, and of course poets, and story tellers.[964] Mathematicians, too, gave great interest to the subject of water, their geometry, for instance, easing operations of storage, flow, and efficient use of the resource. The Moroccan Ibn al Banna's *Tanbih al-albab* studies the calculation of drop irrigation canals.[965]

The place of water in gardens and gardening was, equally, central. 'Without water the fruit gardens, which in the Arab consciousness are the gardens of paradise, could not survive,' says Lapidus.[966] 'Water, principally, we cannot imagine a beautiful Islamic garden doing without,' also says Marcais.[967] In gardens, just as in courtyards of buildings of a religious nature, water was regarded as a symbol of purity, and since paradise overflowed with water, tanks in mosques and theological colleges were filled to the brim.[968]

[961] For all these points, see, for instance:
D.R. Hill: *Islamic Science and Engineering* (Edinburgh University Press, 1993).
[962] See for instance:
-N. Smith: *A History of Dams* (The Chaucer Press, London,1971).
-A. Pacey: *Technology in World Civilization, a Thousand Year History* (The MIT Press, Cambridge, 1990).
[963] A. Solignac: Recherches sur les installations hydrauliques de kairaouan et des Steppes Tunisiennes du VII au Xiem siecle, in *Annales de l'Institut des Etudes Orientales*, Algiers, X (1952); 5-273.
[964] Al-Muqaddasi: *Ahsan at-taqasim;* op cit.
Ibn Battuta: *Voyages d'Ibn Battuta*, Arabic text accompanied by French translation by C. Defremery and B.R. Sanguinetti, preface and notes by Vincent Monteil, I-IV (Paris, 1968, reprint of the 1854 ed).
[965] A Djebbar: Mathematics in medieval Maghreb; *AMUCHMA-Newsletter* 15; Universidade Pedagógica (UP), (Maputo Mozambique, 15.9.1995).
[966] I. Lapidus: *Muslim Cities*; op cit; p. 70.
[967] G. Marcais: Les Jardins; op cit; p. 234.
[968] J. Lehrman: *Gardens*; op cit; p. 278.

And the faith, once more, was the greatest of all inspirations. Qura'nic descriptions of Paradise put great stress on the presence of moisture and water, 'equally as or even more important than the soil,' Dickie reminds.[969] The Qur'an says of the believers:

> 'Theirs shall be gardens of Eden, underneath which rivers flow.' (18: 30.)
>
> 'And for those who believe and do righteous works, We will cause them to enter gardens underneath which rivers flow, to dwell therein eternally: they shall have purified companions, and We will cause them to enter abundant shade.' (4: 57).

Indeed, one can understand neither the Islamic garden nor the attitude of the Muslim toward his garden until one realises that the terrestrial garden is considered a reflection or rather an anticipation of Paradise.[970]

It is a state of blessedness that is promised in the Qur'an as reward to the faithful; reference is made to 'spreading shade;' 'fruits and fountains, and pomegranates;' 'fountains of running water;' and 'cool pavilions'. For believers who perform righteous acts, the Qur'an promises that the ' Gardens of paradise shall be their hospitality, therein to dwell forever, desiring no removal from them.'[971]

Shade and water as an antidote to the aridity, heat and death of the desert were the first requirements. When gardens were made into a paradise on earth, they became a foretaste of the paradise to come after death.[972] 'May rain clouds water his grave ad revive it and may the moist garden carry to him its fresh perfume,' is, says Dickie, an Arab funerary inscription. It perpetuates the sensate outlook of the Arabs who, already in the 11th century, sought in their gardens a voluptuous gratification of the senses from their shade, water and scents.[973]

The gentle trickle of water, in the hot summers of the Islamic land, most particularly, invites contemplation without and within. At the Lion Court in Alhambra (Grenada), nearly all the main rooms of the palace had water running through them in a marble groove in the floor, and the garden of the Generalife, the summer palace, is typical of the love of gardens with walks and fountains, all arranged in close relation to the living quarters.[974] 'With the constantly renewed trees and flowers and the flowing and

[969] J. Dickie: Rauda, in T*he Dictionary of the Middle Ages*; vol 10; pp. 261-2.
[970] J. Dickie: The Islamic Garden in Spain; op cit; p. 90.
[971] J. Lehrman: Gardens; Islam; op cit; p. 277.
[972] F.R. Cowell: *The Garden as a Fine Art*; op cit; p. 75.
[973] Ibid.
[974] F.B. Artz: *The Mind*; op cit; p. 173.

bubbling of its water, the Generalife evokes, even more than the Alhambra, the private life of the Nasrid princes. And the architects of Grenada have never surpassed this perfect alliance of gardens, water, landscape, and architecture, which was 'their supreme aim, and sets the seal upon their art,' says Terrace.[975] Elsewhere, in Cordova, some of the gardens had tempting names, which seem to invite one to repose beside the trickling waters and enjoy the sweet scent of the flowers and fruit.[976] The 'Garden of the Water Wheel' gives one a sense of lazy enjoyment, listening to the monotonous creaking of the wheel that pumped up the water to the level of the garden beds; and the 'Meadow of Murmuring Waters' must have been an entrancing spot for the people of Cordova in the hot weather, notes Lane Poole.[977] In Toledo, King al-Mamun (r. 1043-1073) was known as 'the great garden lover,'[978] and his garden had a pavilion called *Majlis an-Naura,* which raised water from the Tajo to supply elegant fountains in which lions spouted water.[979] In the chronicle of al-Maqqari, Ibn Badrun relates that:

> 'King al-Mamun of Toledo ordered the construction of a lake, in whose centre stood a crystal pavilion; water was lifted to its roof, and from there it ran down to all sides, like artificial rain, into the water below. The pavilion was thus enclosed in a mantle of limpid water which, being constantly renewed, was also fresh, and Al-Mamun could sit inside without being touched by the water.'[980]

In the middle of the pond, he had a mechanical device set up that threw the water high into the air, so that it fell down again all over the sides of the pavilion. The caliph was able, thus, to sit in a cool place with water all around him, even by lamplight.[981]

Throughout the Islamic world, fountains, cascades, channels and pools provided a great variety of sights and sounds, and water could be made deep, dark, and tranquil, or swiftly flowing and scintillating.[982] Edges of fountains and pools were often carved in stone or marble, whilst at night, candles were set on tiny rafts to reflect in the still water of pools, or glowing lamps were placed behind glistening cascades in carved niches which during the day

[975] H. Terrasse: Gharnata; in *Encyclopaedia of Islam*; op cit; vol 2; p. 1019.
[976] S. Lane-Poole: *The Moors in Spain* (Fisher Unwin; London; 1888), pp. 132-3.
[977] Ibid.
[978] G.S. Colin: Filaha; *Encyclopaedia of Islam*: New edition (Leiden; 1986), Vol 2, p. 901.
[979] T. Glick: *Islamic*; op cit; p. 237.
[980] In Al-Maqqari: *Nafh Al-Tib*, op cit; vol 2; Book vii; chapter v; p. 263.
[981] M.L. Gothein: *A History of Garden Art*; op cit; p. 153.
[982] J. Lehrman: Gardens; Islam; op cit; p. 278.

contained flower vases.[983] The Tulunid Sultan Rhumarawaih, in his garden, had many dwarf palms, whose fruit, could be reached and picked by anyone standing up, or even sitting.[984] Their trunks were covered with gilded copper finely wrought, between the copper and the trunk leaden pipes were introduced from which water was thrown upward.[985] The concealed water appeared to come straight out of the palm branches, whence it was received in a fine basin and was then conducted by canals all through the garden, which, Gothein notes, may perhaps be the original model for artificial fountain trees.[986]

In Muslim India, the Mughal garden of Shah Jahan's Shalamar in Lahore exhibited:

> 'Sheets of cool, quiet water contrasted with shawls of fast running white water thrown over chadars; deep throated marble chutes sometimes inlaid with coloured marble. The play of water in countless fountains caused the light to sparkle and covered the surface with ripples. And at night, tiny oil lamps set in marble niches sparkled from behind cascades, while flickering lights were reflected from tiny boats floating across the dark water.'[987]

In a 17th century garden in Tunis, there was an immense four cornered basin into which water poured down steep as a wall; at either end was a grand pavilion, standing on pillars of marble and mosaic. Other basins, kiosks and tall, shady trees made this dwelling the favourite haunt of the sultan.[988]

Water works also symbolised the other dominant feature of early Islamic civilisation, its boldness and confidence, its faith in the grandiose and daring. For instance at Samarra, where impressive architecture was greened by a multitude of gardens, and water occupied the central place, and on a vast scale, erupting out of the barrenness of the desert. The city's founder, Caliph Mu'tasim's (r. 836-876) first concern was to conduct water from the Tigris by canals.[989] He had trees imported from other parts, and as there was so much water at hand, everything flourished, the geographer Al-Yaqubi in the year 889, saying how in every garden there had to be a villa, and therewith halls, ponds, and playgrounds for riding

[983] Ibid.
[984] M.L. Gothein: *A History of Garden Art*; op cit; pp. 149-50.
[985] Ibid.
[986] Ibid.
[987] The Mughal Garden at www.unesco.org/whc/whreview/article1.html
[988] M.L. Gothein: *A History of Garden Art*; op cit; pp. 150.
[989] Ibid; pp. 146-8.

and the game of ball.[990] Mu'tasim's son, al-Mutawakkil, built a palace, entered by wide courts, no doubt paved, and ornamented with flowering plants in pots. The chief palace looked towards the river and had a large garden in front. One of the palaces had a garden on the river side and was enclosed by a wall, with pillars that end on the bank with finely decorated pavilions, and at every extremity is a harbour for boats.[991] The caliph's palace and its courts stood above the high river bank as on a prominent platform, which may possibly be a garden, and further inland, one passes through an immense door into a great ornamental garden court, which is watered from a basin in the centre by means of a long canal.[992] At the end there is a sort of grotto, with a basin in front of it, behind and crosswise to the main line is yet another enclosure. By the side of the garden is a large round place deeply dug, possibly for an arena, possibly for a large tank.[993]

The same grand designs were found in Spain. In the neighbourhood of Cordova, Caliph Abd Errahman built a new town, Az-Zahra, the Flower, and again, on a huge scale. The whole plan was a of terrace formation, lowest of all were extensive gardens, orchards, aviaries, and cages for animals, all confined within their own borders.[994] The lovely view of the garden was particularly famed, the finest part of all being the a golden hall and vaulted pavilion; and here again there was a cistern of quicksilver.[995] A great number of fountains and artificial ponds adorned the gardens and the rooms. Very remarkable was the green cistern in the Caliph's bedroom, adorned with many gilded animals, water gushing out of their mouths.[996]

Great designs demanded a high degree of engineering skills. Water was often led from its source along a canal, aqueduct, or pipe to a tank, cistern, or public fountain.[997] The walled Agdal gardens of Marrakech (under Almohad rule) stretched for two miles south of the Casbah, and were irrigated by water brought from far in the mountain.[998] The Almohad ruler Abd al-Mumin built the royal palaces in the city of Marrakech, and one of his gardens is said to have been six miles long and to have contained huge water reservoirs.[999] In gardens and courtyards water was often lifted to a

[990] Ibid.
[991] Ibid.
[992] Ibid.
[993] Ibid.
[994] Ibid; p. 152.
[995] Ibid; p. 152.
[996] Ibid; p. 152.
[997] J. Lehrman: Gardens; Islam; op cit; p. 278.
[998] M. Brett: Marrakech in *Dictionary of the Middle Ages*; op cit; vol 8; pp 150-1.
[999] R. Landau: *Morocco* (Elek Books Ltd, London 1967), p.81.

high storage tank to provide a head for the fountains; subsequently it was led to flower beds, kitchen gardens, or fields.[1000] In general, gardens within the urban boundaries were irrigated by means of canals led off the watercourses, or, when there were only wells, by means of simple channels leading from basins filled with water by means of norias (large water wheels), or simpler water raising contrivances.[1001] An instance is the Palace of Galiana situated in the valley of Toledo on the banks of the Tagus, where remnants of the device used by the Muslims to draw the water from the river still stand, now restored.[1002] Al-Idrisi tells us in his Description of Spain:

> 'The gardens surrounding Toledo are irrigated by canals over which water wheels have been erected to carry water to the vegetable gardens. These produce remarkable quantities of unusually beautiful and delicious fruit. On all sides lovely estates and castles can be admired.'[1003]

Andrea Navagero, the ambassador sent from Venice in 1526, confirms these descriptions of the Palace of Galiana:

> 'The Tagus rises in Aragon, not far from Catalayud, where it is said Bilbilis, the birthplace of Martial, once stood. Before it reaches Toledo, the river flows through a plain called Huerta del Rey (King's Orchard) which is watered by norias, wheels invented by the Arabs to draw water from the river. Because of this, the plain is covered by trees and bears much fruit, and the whole of it is cultivated and divided into orchards. They supply the town with vegetables, especially cardoons, carrots and egg-plant, which are much in demand here. In this plain there is an old ruined palace called Galiana. Galiana was the daughter of a Moorish king... the ruins show the palace to have been very fair and its site most peaceful.'[1004]

In the garden of the Alcazar of Cordova, according to Al-Maqqari, was a water jet of surprising strength, attaining a height never before seen in east or west.[1005] The Muslims, as De Casa Valdes reminds us, being the first to construct such vertical water spouts.[1006] At Madinat az-Zahra, in Muslim

[1000] J. Lehrman: Gardens; Islam; op cit; p. 278.
[1001] Editor: Irrigation in North Africa and Muslim Spain; *Encyclopaedia of Islam;* under Ma'a; vol 5; p. 877.
[1002] Marquesa de Casa Valdes: *Spanish Gardens*; op cit; p. 25.
[1003] Al-Idrisi: *Viajes de extranjeros por Espana y Portugal*, compiled by J. Garcia Mercada; ed. Aguilar (Madrid; 1952), vol 1; p. 192.
[1004] Navagero: *Viaje por Espana; in Viajes de extranjos por Espana*; op cit; p. vol 1; p. 845.
[1005] Al-Maqqari: *Nafh Al-Tib;* op cit; vol 1; p. 208.
[1006] Marquesa de Casa Valdes: *Spanish Gardens*; p. 30.

times, the water was so balanced in the complex of lead pipes that the play of every jet was dependent on the play of every other jet, and manipulation of a single valve could alter the water patterns of the whole systems.[1007]

Just as their care for water promoted engineering skills, efforts by Muslims to re-create their earthly paradises gave rise to a rich botanical literature.

4. Garden Literature:

In the following part, under the chapter on agriculture, there will be plenty on Islamic farming and botanic literature, so, here, the interest in such literature will be kept minimal, just enough to illustrate the Muslim use of scientific writing on gardens and gardening.

The two successive superintendents of the gardens at Toledo, Ibn Wafid (997-1074)[1008] and Ibn Bassal (fl. 11th century),[1009] were amongst the most significant figures in the history of gardening. Their garden was very large, being outside the city on the opposite bank of the Tagus near the modern railways station, and is still known as the Huerta del Rey, the King's Garden.[1010] The sultan whom they served, Al-Mamun, made use of the best hydraulic science to provide the gardens with irrigation and himself with a pavilion cooled by streams poured down upon it on each side.[1011] Both Ibn Wafid and Ibn Bassal wrote treatises that have survived to be rediscovered in recent years. Ibn Wafid's main work is on simple drugs (*Kitab al-adwiya al-mufrada),* and is partly extant in a Latin translation (*De medicamentis simplicibus*).[1012] According to a later Muslim writer, Ibn Wafid spent twenty five years gathering the information he included in his treatise, which was five hundred pages long, and of which the Latin translation is

[1007] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 82.
[1008] E. H. F. Meyer: *Geschichte der Botanik;* I-IV, Konigsberg (1854-7); vol. 3, pp. 205-8; E. Calvo: Ibn Wafid: in the *Encyclopaedia of the History of Science, Technology, and Medicine in Non Western Cultures*; H. Selin Editor (Kluwer Academic Publishers; Dordrecht/Boston/London, 1997), p.438.
[1009] Ibn Bassal: *Libro de agricultura*, Jose M.Millas Vallicrosa and Mohammed Azinan eds (Tetuan: Instituto Muley al-Hasan, 1953).
[1010] J. Harvey: *Medieval Gardens;* op cit; p. 40.
[1011] Ibid.
[1012] F. Wustenfeld: *Geschichte der arabischen* Aerzte (Gottingen; 1840), p. 82.

only a fragment.[1013] There are also translations of it into Catalan and also Hebrew.[1014] Whilst Ibn Wafid included a chapter on flowering and aromatic plants, Ibn Bassal was primarily a botanist and also a horticulturist of distinction.[1015] He wrote for Al-Mamun a lengthy treatise on agronomy: *Diwan al-Filaha,* which was eventually abridged into one volume with sixteen chapters.[1016] The 16 chapters deal with waters, soils, manures, the choice of ground and its preparation; trees, methods of planting, pruning, grafting and the secrets of grafting; pulse and industrial crops, roots, vegetables and salads, aromatic and ornamental plants, etc.[1017] The most interesting chapter deals with flowers such as the rose, the wallflower and stock, violet, lily, narcissus, basil, marjoram, balm, rue, camomile, etc.[1018] From his list, as well as his reference to the blue lily and various sorts of jasmine he studied on his travels, we can see that the purely ornamental garden was already highly developed. Ibn Bassal's work is original, based upon his own practical experience.[1019] His personal experiments were remarked upon by his contemporaries, notably al-Tignari of Albolote near Grenada.[1020] From al-Tignari and from other sources we get scraps of information on Ibn Bassal's experimental writing:

> 'The eminent master Ibn Bassal was learned both in theoretical and experimental agriculture, an expert cultivator who has mastered the subject. He told me that he had seen the Blue lily (?) Iris germanica) in Sicily and in Alexandria; 'I saw this species of garden asparagus sown by Ibn Basal in the sultan's garden: 'all these sorts of jasmine are found in the neighbourhoods of Valencia, Sicily, Alexandria and Khorasan, as I have been told by Ibn Bassal among others.' Al-Tignari gives details of Ibn Bassal's method of dealing with a disease that infected the orange trees, cutting down and burning those infected, and later making choices among the new shoots from the root. He also carried out experiments in planting the pomegranate, and discovered that the fig and the vine could be planted in any season. Ibn Bassal had travelled widely and collected plants in Sicily, Egypt, Mecca, Khorasan, as well as in various parts

[1013] L Leclerc: *Histoire de la medecine arabe*; vol. 1 (Paris; 1876); p. 546.
[1014] Emilia Calvo: Ibn Wafid; op cit; p.438.
[1015] J. Harvey: *Medieval Gardens;* p. 40.
[1016] G.S. Colin: Filaha; *Encyclopaedia of Islam*: New edition (Leiden; 1986), Vol 2, p. 901.
[1017] Ibn Bassal: *Libro de agricultura*, In J. Harvey: *Medieval Gardens;* p. 41.
[1018] J. Harvey: *Medieval Gardens;* p. 41.
[1019] Ibid.
[1020] Ibid; p. 40.

> of Spain. In his later career at Seville he experimented in the cultivation of imported seeds.'[1021]

What the Muslim gardeners regarded as correct rules for planting, and some of the garden plants which they favoured, can be gathered from an authoritative 12th century work on agriculture and horticulture written by the agronomist Yahia Ibn Muhammad (Abu Zakaria), Ibn al-Awwam (fl end of 12th century).[1022] He wrote a treatise on agriculture, *Kitab al-filaha* (Book of Agriculture*),*[1023] which is the most important Muslim work as well as the most important mediaeval one on the subject.[1024] Ibn al-'Awwam's treatise covers 585 plants, and explains the cultivation of more than fifty different fruit trees, besides containing striking observations on the different kinds of soil and manure and their respective properties, on various methods of grafting, on sympathies and antipathies between plants, etc.[1025] This book of Agriculture relies on the practical experience of the author.[1026] In relation to gardening, Ibn Al-Awwam, besides dealing with a much larger number of species, breaks new grounds by suggesting, here and there, principles of design.[1027] Thus, cypresses, for instance, might be used to mark corners of beds and in rows alongside main walks, and other trees suitable for planting in rows were cedars and pines, with citrus fruits and sweet bay, while jasmines were presumably intended to be trained on trellis or pergolas.[1028] Ibn al-Awwam says that all garden doorways should be framed by clipped evergreens, that cypresses should be used to line paths and grouped to mark the junctions of paths, and he objects to the mixing of evergreen with deciduous trees.[1029] He liked to see canals and pools shaded by trees or bowers, to prevent excessive loss of water by evaporation.[1030] Pools of water should be shaded by the planting of trees nearby, such as the pomegranate, with the elm, poplar and willow.[1031] Plants named in his text include lemon and orange trees, pines and most of our common deciduous trees, cypresses, oleander, myrtle and rose as the only flowering shrubs; violets, lavender, balm, mint, thyme, marjoram, iris, mallow, box and bay

[1021] Ibid.
[1022] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 84.
[1023] Spanish version by Joseph A. Banqueri; 2 vols., folio (Madrid 1802); French version: *Le Livre de l'agriculture*, by Clement-Mullet; 2 tomes in 3 vols (Paris 1864-1867).
[1024] G. Sarton: *Introduction*; op cit; vol 2; pp. 424-5.
[1025] Ibid; p. 425.
[1026] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 84.
[1027] J. Harvey: *Medieval Gardens;* op cit; p. 41.
[1028] Ibid.
[1029] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 84.
[1030] Ibid.
[1031] J. Harvey: *Medieval Gardens;* op cit; p. 41.

laurel.[1032] He lays much stress on aromatics, as, indeed, did all the Islamic gardeners.[1033] For hedges, box and laurel could be used, as well as climbing plants such as ivy, jasmine, and the grapevine was considered as an ornament.[1034]

Between Ibn Bassal and Ibn al-Awwam (1080-1180) there was a great deal of introduction of exotic plants into Spain, as well as the bringing into cultivation of wild native, expressly advocated by Ibn al-Awwam in connection with ivy and with a great binkweed known as poor man's rope, bearing handsome bell shaped flowers: these, he suggests, could be trained on a trellis for display.[1035] Violets should be sown in shady and sheltered beds, and also in new perforated flower pots, in either case, laying a bed of crumbled brick and builder's rubbish mixed with a like quantity of pigeon's dung. The author had himself seen them grown in this way at Seville and Cordova.[1036]

Muslims were extremely fond of flowers, and from early Islamic manuscripts, Dickie compiled a list of the fifty two common flowers mentioned by Muslims up to the 11th century.[1037] Pleasurable scents as well as colours were sought, with jasmine, narcissus, violet, mauve stock, yellow wallflower, red rose, white lily, blue iris, water lily, almond blossom, marguerite, camomile, trumpet narcissus, poppy, pomegranate blossom; myrtle, basil, lavender, carnation, orange blossom, marjoram, oleander, thyme, mint, saffron, lupin, as well as other flowering trees and shrubs: laurel, pear, plum, etc.[1038]

5. Impact on History:

The Islamic garden impacted considerably on the subsequent history of the Western garden, and was itself to be impacted upon, but in the very reverse manner, by Western history.

[1032] E. Hyams: *A History of Gardens and Gardening*; p. 84.
[1033] Ibid.
[1034] J. Harvey: *Medieval Gardens;* op cit; p. 41.
[1035] Ibid; pp. 41-2.
[1036] Ibid.
[1037] In F.R. Cowell: *The Garden as a Fine Art;* op cit; p. 76.
[1038] Ibid.

The great value of Islamic botanical treatises was recognised in Christian Spain, where translations of some of them into Castilian were made as part of the great programme of scientific works initiated by Alfonso X. Of these, a substantial part of the versions of the works of Ibn Wafid and Ibn Bassal has come down to our times.[1039] The *Majmu fi'l Filaha* (Compendium of Farming), was attributed to Ibn Wafid (Abenguefith) but in fact was a work by Al-Zahrawi, and was translated to two romance languages, Catalan[1040] and Castilian.[1041] This work had great influence on the 'Renaissance' work of agronomy, the *Agricultura General* of Gabiel Alonso Herrera (d. c. 1539). The 11th century farming treatise by Ibn Bassal, which in its abridged form was published at Tetuan in 1955, was translated into Castilian in the Middle Ages.[1042] The significance of these translations, and of the original scientific works produced under Alfonso the learned, lies largely in the fact that they were in vernacular, languages not in Latin.[1043] There is a presumption that the users of these works were largely laymen with a direct interest in craft skills, and for such readers, the precepts of a practical gardener like Ibn Bassal, writing from his own experience, would be of real importance.[1044] At a later date, we shall find comparable attempts to put practical advice into English, along the translations such as those made by John Trevisa, Henry Daniel and others at the end of the 14th century.[1045] Islamic scientific influence also travelled through clerks belonging to royal households, who moved to and fro on diplomatic missions.[1046] Some served both in England and in Spain, like Geofrrey of Everseley who was in the employ of Edward I and also Edward's brother in law, Alfonso of Castile (r. 1252-1284) in 1276-82, at the very time when the learned king was producing the scientific treatises and the Alfonsine astronomical tables which have immortalised his name.[1047]

[1039] J. Harvey: *Medieval Gardens;* op cit; pp. 43-4.
[1040] The medieval Catalan version can be found in the Bibliotheque Nationale of Paris; Number 93 by A. Morel Fatio, *Catalogue des manuscrits espagnols et des manuscrits Portugais* (Paris, 1982), pp. 332-3.
[1041] Text in Castilian edited by J.M. Millas Vallicrosa: La traduccion castellana del Tratado de Agricultura' de Ibn Wafid; *Al-Andalus;* 8 (1943), pp. 281-332.
[1042] R. B. Serjeant: Agriculture and Horticulture: Some cultural interchanges of the medieval Arabs and Europe; in *Convegno Internationale: Oriente e occidente Nel Medioevo Filosofia E Scienze;* Aprile 1969 (Academia Nationale Dei Lincei; Roma; 1971), pp. 535-41. p. 540.
[1043] J. Harvey: *Medieval Gardens;* op cit; pp. 43-4.
[1044] Ibid.
[1045] Ibid.
[1046] Ibid; pp. 42-3.
[1047] Ibid.

In the 12th century, the art of gardening took a most important step forward, for the whole spiritual life of the West was astonishingly uplifted.[1048] We are now at the time of the crusades: the Christian soldiery beheld, in the East, gardens of a splendour beyond their wildest dreams.[1049] The poets listened to their tales, and from now onward they sang of the East, which was the darling theatre for the adventurous knight errant.[1050] 'Gladly,' says Gothein, 'do we try to depict these distant scenes, and the tale of Herzog Ernst is pleasant enough':

> 'Near they came to a valley in a garden hall; it was very roomy, and therein stood many cedar trees rich in leafy bowers; they found two rivulets also that rose there and flowed through the grounds, winding as they pleased, and as the master had planned who made all by his skill. They found a bath, too, bright and clean, wrought of green marble, well walled in and overhung with fifty high branches; the streams were brought herein by silver channels. Much water ran out in a silver course from the thicket, and flowed around the castle, in straight or curving lines around the whole castle. All the paths were of white marble, all bridges made where men would walk.'[1051]

Peaceful assimilation of ideas also went on through such channels as the medical school of Montpellier, founded by Muslim physicians and incorporated by 1221.[1052] Montpellier was the northern outpost of Spanish science, for it belonged to the crown of Aragon from 1202 to 1349. Its university formed a main international link, and appropriately came to possess one of the oldest botanical gardens in France, opened by Henry IV in 1593.[1053] Those started in Pisa (1543) and Padua (1545), Parma and Florence in 1545, Bologna in 1568, Leyden in 1577, Leipzig in 1580, Konigsberg in 1581, Paris (le Jardin Royal du Louvre) in 1590, Oxford in 1621 etc,[1054] are regarded as the earliest in the world, which overlooks the far older gardens of Muslim botanists under the patronage of Muslim rulers.[1055] In 1031 the western caliphate broke up into succession states, the most important centred on Toledo and Seville, and at both were notable

[1048] M.L. Gothein: *A History of Garden Art*; op cit; p. 190.
[1049] Ibid.
[1050] Ibid.
[1051] Ibid.
[1052] J. Harvey: *Medieval Gardens;* op cit; p. 40.
[1053] Ibid.
[1054] See: A. Chiarugi: Le date di fondazione dei primi orti botanici del mondo,' *Nuovo giornale botanico italiano* new ser. LX (1953) 785-839; A.W. Hill: The History and function of botanical gardens; *Annals of the Missouri Botanical Garden;* II (1915) 185-240; 195 fwd; F. Philippi: *Los jardines botanicos* (Santiago de Chile; 1878), etc.
[1055] J. Harvey: *Medieval Gardens;* op cit; p. 40.

palace gardens of the sultans, maintained as scientific botanical gardens.[1056] The one at Toledo was founded by Ibn Wafid (999-1075), and his colleague and successor Ibn Bassal continued working there until the Christian conquest of 1085 forced him to seek sanctuary further south where he improved the royal gardens of Seville for sultan al Mu'atamid (r. 1061-1091).[1057] The most famous of these scientific collections of plants was set up a century later at Guadix by Mohammed Ibn Ali Ibn Farah for the Almohad sultan An-Nasir (r. 1199-1214).[1058] Only many centuries later, as already noted, did Europe possess similar botanical gardens which acted as the same kind of medium for plant diffusion that the Islamic world had experienced in the middle ages.[1059] The comparative study of plants and the systematic introduction of exotic species with experiments in their cultivation all derive from these Muslim gardens on European soil.[1060]

The Islamic garden influence is very obvious in Sicily. In Norman Sicily, the 'baptised sultans,' as they were called, of the Hauteville family, took over the gardens of the Muslim emirs whom they conquered; gardens which did not differ in any important particular from those of Iran, northern India or southern Spain.[1061] The suburbs of Palermo, like the Zisa, whose name derives from the Arabic al-Aziz, "the Splendid",[1062] highlight the Islamic influence, which persisted even under William I (The Bad) (r.1154-1166), the heir to Roger II.[1063] He built a number of retreats in the outskirts of Palermo, of which none were more splendid than the "Zisa," the geometric structuring of the design suggesting a relation to woven textile patterns, a frequent means of transmission of ornamental motifs during the middle ages.[1064] The palaces of Emperor Frederick II disclosed a marked partiality for Muslim customs and architecture, outworks of vast extent defended their approaches, and in all of them were courts and gardens fragrant with the blossoms of jasmine and orange and surrounded by secluded apartments designed for the occupants of the imperial seraglio.[1065] Attached to some of these delightful retreats were extensive menageries,

[1056] Ibid.
[1057] A. Watson: *Agricultural;* op cit; chap 22.
[1058] J. Harvey: *Medieval Gardens;* p. 40.
[1059] A. Watson: *Agricultural*, op cit, chap 22.
[1060] J. Harvey: *Medieval Gardens;* p. 40.
[1061] E. Hyams: *A History of Gardens and Gardening*; op cit; pp. 91-2.
[1062] J. D. Breckenridge: The Two Sicilies; in *Islam and the Medieval West*; S. Ferber Editor (State University of New York; 1975), pp 39-59; at p. 55.
[1063] Ibid.
[1064] Ibid.
[1065] S.P. Scott: *History;* op cit; vol 3; p. 51.

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[1049] Ibid.
[1050] Ibid.
[1051] Ibid.
[1052] J. Harvey: *Medieval Gardens;* op cit; p. 40.
[1053] Ibid.
[1054] See: A. Chiarugi: Le date di fondazione dei primi orti botanici del mondo,' *Nuovo giornale botanico italiano* new ser. LX (1953) 785-839; A.W. Hill: The History and function of botanical gardens; *Annals of the Missouri Botanical Garden;* II (1915) 185-240; 195 fwd; F. Philippi: *Los jardines botanicos* (Santiago de Chile; 1878), etc.
[1055] J. Harvey: *Medieval Gardens;* op cit; p. 40.

palace gardens of the sultans, maintained as scientific botanical gardens.[1056] The one at Toledo was founded by Ibn Wafid (999-1075), and his colleague and successor Ibn Bassal continued working there until the Christian conquest of 1085 forced him to seek sanctuary further south where he improved the royal gardens of Seville for sultan al Mu'atamid (r. 1061-1091).[1057] The most famous of these scientific collections of plants was set up a century later at Guadix by Mohammed Ibn Ali Ibn Farah for the Almohad sultan An-Nasir (r. 1199-1214).[1058] Only many centuries later, as already noted, did Europe possess similar botanical gardens which acted as the same kind of medium for plant diffusion that the Islamic world had experienced in the middle ages.[1059] The comparative study of plants and the systematic introduction of exotic species with experiments in their cultivation all derive from these Muslim gardens on European soil.[1060]

The Islamic garden influence is very obvious in Sicily. In Norman Sicily, the 'baptised sultans,' as they were called, of the Hauteville family, took over the gardens of the Muslim emirs whom they conquered; gardens which did not differ in any important particular from those of Iran, northern India or southern Spain.[1061] The suburbs of Palermo, like the Zisa, whose name derives from the Arabic al-Aziz, "the Splendid",[1062] highlight the Islamic influence, which persisted even under William 1 (The Bad) (r.1154-1166), the heir to Roger II.[1063] He built a number of retreats in the outskirts of Palermo, of which none were more splendid than the "Zisa," the geometric structuring of the design suggesting a relation to woven textile patterns, a frequent means of transmission of ornamental motifs during the middle ages.[1064] The palaces of Emperor Frederick II disclosed a marked partiality for Muslim customs and architecture, outworks of vast extent defended their approaches, and in all of them were courts and gardens fragrant with the blossoms of jasmine and orange and surrounded by secluded apartments designed for the occupants of the imperial seraglio.[1065] Attached to some of these delightful retreats were extensive menageries,

[1056] Ibid.
[1057] A. Watson: *Agricultural;* op cit; chap 22.
[1058] J. Harvey: *Medieval Gardens;* p. 40.
[1059] A. Watson: *Agricultural*, op cit, chap 22.
[1060] J. Harvey: *Medieval Gardens;* p. 40.
[1061] E. Hyams: *A History of Gardens and Gardening*; op cit; pp. 91-2.
[1062] J. D. Breckenridge: The Two Sicilies; in *Islam and the Medieval West*; S. Ferber Editor (State University of New York; 1975), pp 39-59; at p. 55.
[1063] Ibid.
[1064] Ibid.
[1065] S.P. Scott: *History;* op cit; vol 3; p. 51.

aviaries, and miniature lakes filled with gold and silver fish.[1066] There was no appliance of Oriental luxury, no means which could contribute to the gratification of the senses, that was not to be found in the Sicilian palaces of Frederick II, notes Scott.[1067] Although such Muslim Sicilian gardens did not survive, travelling soldier-noblemen and priests brought ideas from what they had seen in Sicily and Calabria into northern Italy, France, and even Germany.[1068]

Muslim gardens, as this chapter has shown in great abundance, were grandiose, but, once more, Western literature in general, endeavoured to phase them out of history, helped in this by the vandalism perpetrated by authorities of diverse ranks. On the first point, briefly, Marquesa de Casa Valdes makes an important remark that:

> 'Muslim Chroniclers have left numerous descriptions of the gardens and fountains that once existed in the palace and town of Medinat al-Zahra. Recent excavations have confirmed these accounts, which had earlier seemed fanciful.'[1069]

The Marquesa here highlights how Western writers on Islamic history and civilisation demean the Islamic impact, and always refer to scholars' glorification of Islamic civilisation as exaggerated, or mere creations of fertile imaginations.

More grave is the second form of onslaught on the Islamic legacy, that is the physical vandalism:

> 'Casual visitors to Spain find it difficult to believe that the magnificent villas and gardens of Muslim Spain ever existed or that they were not taken over and enjoyed by some at least of the Christians who came to occupy and rule the land,' [observes, Cowell.][1070] 'Such notions,' [he pursues,] 'are misplaced because they rest upon the tacit assumption that it would have been natural for Christian victors in the holy war against the followers of Islam to have enjoyed gardens as much as the Muslims did or as most people do today. Spanish Christians were sternly forbidden some of the garden joys of the Muslims. To be able to show that anyone had washed in a pool near a mosque, as Muslims ritual required the faithful to do, might set inquisitors to work. Such was the danger

[1066] Ibid.
[1067] Ibid.
[1068] E. Hyams: *A History of Gardens and Gardening*; op cit; pp. 91-2.
[1069] Marquesa de Casa Valdes: *Spanish Gardens*; op cit; p. 28.
[1070] F.R. Cowell: *The Garden as a Fine Art*; op cit; p. 76.

> that the very name of the Court of the Pool at Grenada had to be changed to the Court of the Myrtle Hedges. Railings and barriers were erected to shut away the charm of such Moorish garden pools that were allowed to remain, while the rigidly orthodox displayed an aversion to water that remained for too long among their less pleasant characteristics.'[1071]

Hyams is even harsher, holding, that:

> 'Just as they were to destroy the great civilisations of Central and South America, the Spaniards destroyed the Muslim civilisation of Andalusia.'[1072]

This destruction is underlined by Scott in a lengthy tirade, here summed up for the sake of convenience; he says:

> 'In the land illuminated by his genius and enriched by his industry, the Spanish Muslim is forgotten or absolutely unknown to the majority of the people The effects and the influence of his civilization are disputed or depreciated; his sites mutilated or entirely destroyed; his palaces transformed into 'the squalid haunts of mendacity and vice, while the leather-clad shepherd watches his flock on the once famous site of gardens adorned with magnificent villas and beautiful with all the luxuriant and fanciful horticulture of the East. Barbaric violence has annihilated the palaces, which lined the Guadalquevir, and whose richness and beauty were the admiration of the world..'[1073]

The same happened in Sicily, where, as Scott continues:

> 'The unrelenting hostility of the See of Rome to everything connected with Islam may account for the total disappearance of the superb architectural monuments which history informs us abounded during Muslim rule. The sumptuous edifices which abounded in every city have disappeared or have been mutilated almost beyond recognition. Ignorance and prejudice of successive generations, in addition to the above named destructive agencies, contributing their share, and no unimportant one, to the obliteration of these memorials of Muslim 'taste and ingenuity.'[1074]

In Spain, few of the of the Muslim gardens still remain. The Muslim gardens of delight with their bright tiles, their fountains and their deep calm pools

[1071] Ibid.
[1072] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 84.
[1073] S.P. Scott: *History;* op cit; Vol II; pp. 537; 553; 557-8.
[1074] Ibid.

that had brought a breath of the far distant Orient to the western limits of Europe faded away.[1075]

> 'In their place,' [Cowell asserts,] 'came the glum austerity of monasticism, progressively degenerating by spiritual inbreeding and ritualistic monotony. Its nadir is to be seen in the funeral gloom of the Escorial, while in Cordoba the great Mosque with the remnants of courtyards and patios still contrive under the southern sun, amid the scented glory of orange blossoms and golden fruits, to recall some of the pleasant features of Islamic paradises and to stir thoughts of distant lands and ways of long ago, of muezzins and camel bells, when the caliph's word was law from the Indian to the Atlantic ocean.'[1076]

The three principal survivors of Spanish Muslim gardens are the Alhambra and the Generalife in Granada, the Alcazar in Seville; the surviving and smaller patio de los Naranjos at Cordova mosque is older than any of these.[1077] And hardly anything of Islamic origin remains of the others. Neglect of irrigation systems by the Spanish Christians led to worse things than the breakdown of ornamental waterworks: as the irrigation system failed the gardens died, and as the gardens died, the villas decayed.[1078]

The fate of the patio of Orange trees (de Los Naranjos) in the Mosque of Cordova is a very good example of such decay. This is perhaps the most ancient walled garden in the world. It was begun by Abd Errahman II about the year 776, then, Al-Mansur the 'Victorious' enlarged the mosque in 987-990 adding eight naves to its eastern side, so that the pond no longer lay at its centre. The Mosque's floor plan shows the Patio of Orange Trees was designed and planted in conjunction with this final addition.[1079] According to Mrs Villiers Stuart, each row of orange trees was aligned with the pillars inside the mosque and with the nineteen arches that once opened onto the garden in the Arab fashion. One can imagine moments of prayer in the mosque; the light filtering through the rows of orange trees must have formed an impressive image of seclusion and poetry. The arches have since been filled in to permit the construction of chapels, and the row of oranges are no longer aligned with the pillars inside the mosque.[1080] An anonymous author, M, on a journey to Spain around the year 1700, described the Patio of Orange Trees as 'a square garden of nearly three acres, planted with very

[1075] F.R. Cowell: *The Garden as a Fine Art*; op cit; pp. 76-7.
[1076] Ibid.
[1077] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 85.
[1078] Ibid; p. 84.
[1079] Marquesa de Casa Valdes: *Spanish Gardens*; op cit; p. 27.
[1080] Ibid; p. 28.

fine large orange trees forming beautiful avenues, just as our elms do in France. This was the work of the Moors, and that country is still richly endowed with their legacy.'[1081] At the beginning of the 19th century, Count Alexander Laborde wrote his Picturesque and Historical Journey through Spain, an account, which, without any doubt, is the most detailed of its kind ever published. About the garden of Cordova, he says:

> 'It is a sort of raised garden over a vast cistern: the four or five feet of earth that cover its vaults suffice to support and feed these lovely trees, among which there are orange trees thirty five or forty feet high and palm trees about sixty feet high. In the centre of this vegetation above the front of the building which forms the fourth façade of the enclosure, rises a square windowed tower crowned with a rotunda that serves as a belfry.'[1082]

The patio has since fallen into neglect. The cistern has apparently been used as an ossuary and access to it is difficult, the hundred year old orange trees described by Laborde at the beginning of the 19th century can no longer be seen, and those that remain lack symmetry.[1083]

The same can be said of the 13th century garden discovered in the Patio de la Cequia in the Generalife in 1959.[1084] Although the immediate motive was to repair damage caused by the fire of 1958, the archaeologist Jesus Bermudes not only found the pavement of the Muslim paths, revealing thereby the primitive cruciform design of the garden, but, underneath the accumulated debris of almost five centuries, located the primitive level of the parterres (50 cm. below that of the paths) and even, pierced in the flanking paths of the watercourse, the outlet holes which made feasible the irrigation of the flower beds.[1085] Now, for some obscure reason, other authorities have disfigured once more the Patio de la Acequia, sealing the outlet holes, burying the Muslim level under half a metre of earth and debris as before and planting once more upon this false surface the no less false plants unknown to the Muslims.[1086]

In Sicily, nearly everything Islamic is gone today, and late medieval travellers in the 14th century, such as Alberti and Fazello, could find only

[1081] Anonymous M: *Viajes;* Ed Aguilar (Madrid; 1952), vol iii; p. 97.
[1082] A. Laborde: Voyage en Espagne; *Revue Hispanique* (Paris; 1925); ed. Fouche Delbose; p. 491.
[1083] Marquesa de Casa Valdes: *Spanish Gardens*; op cit; p. 28.
[1084] J. Dickie: The Islamic Garden; op cit; p. 98.
[1085] El-Generalife depues del incendio de 1958,' *Cuadernos de la Alhambra;* 1 (1965); pp. 9-39.
[1086] J. Dickie: The Islamic Garden; op cit; p. 98.

poor remains, which were strung round the city of Palermo, like a 'necklace of a fair lady's neck.'[1087] Alberti does describe the Villa la Ziza, which is still standing, but so completely rebuilt that one can scarcely find the court with the fountain that he admired so much.[1088] The whole of the house floor is traversed by a stream, with a fine decorated hall above it two storeys and a vaulted roof. In front of the hall, Alberti saw a wonderful fish pond, into which streamed the fountain water, and the middle of it was a good kiosk, attached by a bridge to the land.[1089]

Another Arab villa, which lay between Palermo and Montreale, is mentioned by Bocaccio in the sixth tale of the fifth day, calling it Cuba, from Arabic Kubba or domed pavilion.[1090] Traces of an important orchard, about two thousand feet long, have been preserved:

> 'There was a splendid garden,' [says the 14th century Italian traveller, Fazello, following older accounts,] 'with all possible combinations of trees, ever flowing waters, and bushes of laurel and myrtle. From entrance to exit there ran a long colonnade with many vaulted pavilions for the king to take his pleasure in. One of these is still to be seen. In the middle of the garden is a large fish pond, built of freestone, and beside it the lofty castle of the king.'[1091]

Hardly anything resembling such late medieval descriptions can be seen today.

Final Words on the Islamic Garden:

The Islamic gardens are nearly all gone today, and not just in former Islamic lands of the Christian West, but also in the land of Islam. From the eastern realm of Islam to its western end, time, invasions, vandalism, neglect, coarseness, the hate for anything Islamic, have erased nearly all such gardens from existence. There remain accounts from contemporaries and from modern day passionate Western lovers of Muslim gardens, and also beautiful lines such as these by Armesto on which to end this chapter:

[1087] M.L. Gothein: *A History of Garden Art*; op cit; p. 159.
[1088] Ibid.
[1089] Ibid; pp. 159-60.
[1090] Ibid; p. 160.
[1091] Ibid.

> 'The strict unity, which characterised Islam was shattered in the 10th century by political schism, the proclamation in both Spain and Egypt of rival caliphates… and other difficulties which made the caliph's rule only nominal. Yet, a sense of comity survived, and travellers could feel at home throughout Dar al-Islam, or to use the language of the poets-in a garden of Islam, cultivated, walled against the world, yielding for its privileged occupants, shades and tastes of paradise.'[1092]

[1092] F. Fernandez Armesto: *Millennium;* op cit; p.35.

Four

LEARNING AND SCHOLARSHIP

Part two of this work will be solely devoted to Islamic sciences, and will be critical of the was mainstream history deals with such sciences. Thus in this chapter, the focus is on Islamic learning as a whole, covering the general aspects of such learning only. This is still a vast subject which, in its own right requires a whole treatise, but just as with other matters mentioned above, only a superficial summary can be made.[1093] The main aspects looked at here are the dominant aspects of Islamic learning; the place of faith and faiths in this experience; the achievements of scholars and scholarship in Islam, and books and libraries in early Islamic civilisation.

1. Dominant Aspects of Islamic Learning:

In the lines of Mutahhr b. Tahir al-Maqdisi (fl 966):

> 'Learning only unveils herself to him who wholeheartedly gives himself up to her; who approaches her with unclouded mind and clear insight; who seeks God's help and focuses an undivided attention upon her; who girds up his robe and who, albeit weary,

[1093] For more see works such as:
-J. Ribera: *Dissertaciones y opusculos;* 2 vols (Madrid, 1928).
-George Makdisi: *The Rise of Colleges* (Edinburgh University Press, 1981).
-George Makdisi: *The Rise of Humanism in Classical Islam and the Christian West* (Edinburgh University Press, 1990).
-J. Pedersen: *The Arabic Book*; tr. by G. French (Princeton University; 1984).

> out of sheer ardour, passes sleepless nights in pursuit of his goal rising, by steady ascent, to its topmost height.'[1094]

The 10th century belletrist Ibn Abd Rabbihi of Cordova (860-940) devoted a whole book to knowledge and education: *al-Iqd al-farid* (The Unique Necklace).[1095] In this work, he reiterates an already established tradition, stressing the importance of knowledge, its usefulness and virtue, exhorting people to pursue it.[1096] He refers to the leading scholars, their qualities and prominent positions, and he defines knowledge and education as:

> 'The pillars upon which rests the axis of religion and the world. They distinguish man from the beast, and the rational from the irrational being. They are the substance of the intellect, the lantern of the body, the light of the heart, and the pole of the soul… The proof is that the intellect grasps the sciences in the same manner sight receives colours, and hearing receives sound. Indeed, the intelligent person who is not taught anything is like one who has no intellect at all. And if a child were not educated and taught to read and write he would be the most stupid of animals and the most wandering beast.'[1097]

Knowledge is one of those concepts that have dominated Islam and given Muslim civilisation its distinctive shape and complexion, insists Rosenthal.[1098] In fact, there is no other concept that has determined Muslim civilisation in all its aspects to the same extent as knowledge.[1099] Learning, by which is meant the whole world of the intellect, Pedersen also notes, engaged the interest of Muslims more than anything else during the golden age of Islam and for a good while thereafter.[1100]

> 'The life that evolved in the mosques,' [Pedersen says,] 'spread outward to put its mark upon influential circles everywhere. Princes and rich men gathered people of learning and letters around them, and it was quite common for a prince, one or more times a week, to hold a concourse (majlis), at which representatives of the intellectual life would assemble and, with

[1094] Mutahhr b. Tahir al-Maqdisi (fl 966) *Livre de la creation et de l'Histoire*, ed. and tr. C. Huart (Paris, 1899-1910) I, 4-5.
[1095] Edition A. Amin (Cairo 1948-53).
[1096] A. Chejne: *Muslim Spain, Its History and Culture* (The University of Minnesota Press; Minneapolis; 1974), pp. 166-7.
[1097] Ibn Abd Rabihi: *Al-Iqd al-Farid;* vol 2; p. 206.
[1098] F. Rosenthal: *Knowledge Triumphant: The Concept of Knowledge in Medieval Islam* (Leiden; E.J. Brill, 1970), p. 2.
[1099] Ibid.
[1100] J. Pedersen: *The Arabic*; op cit; p. 37.

> their princely host participating, discuss those topics that concerned them, just as they were accustomed to do when meeting in their own milieu.'[1101]

In the search for knowledge, I and L Al Faruqi explain, 'everybody felt himself to be a conscript.'[1102]

> 'Never before and never since', [admits Briffault,] 'on such a scale has the spectacle been witnessed of the ruling classes throughout the length and breadth of a vast empire given over entirely to a frenzied passion for the acquisition of knowledge. Learning seemed to have become for them the chief business of life. Caliphs and emirs hurried from their Diwans to closet themselves in their libraries and observatories. They neglected their affairs of the state to attend lectures and converse on mathematical problems with men of science.'[1103]

And where and when the ruler was absent, it was the closest in family ties on to whom this duty fell. In Muslim Spain, for instance, A1-Mondhir, a brother of Caliph Al-Hakem (r. 961-972), who, in the absence of the sovereign, presided over the contests of the famous literary institute in which the talents and the learning of the aspiring scholars of the land were exhibited.[1104]

Early in the 9th century, under the sponsorship of enlightened rulers, such as al-Mamun, Al-Mutawakkil, Abd Errahman II, and the Aghlabid rulers of al-Qayrawan, were established centres for advanced learning in the Muslim world. By the end of the 11th century 'university-type institutions' were established in most of the chief cities.[1105] Earliest among such institutions was the first scientific academy of its genre: *Bayt al-Hikma*, or House of Wisdom, which was established in Baghdad in the 9th century. It was primarily a research institute, with, as Artz lists, a library, scientific equipment, a translation bureau, and an observatory. Instruction was given in rhetoric, logic, metaphysics and theology, algebra, geometry, trigonometry, physics, biology, medicine, and surgery.[1106] At the end of the 9th century, under Aghlabid rule, a Bayt al-Hikmah (House of Wisdom) was established in Al-Qayrawan, Tunisia, rivalling its counterpart in Baghdad in

[1101] Ibid.
[1102] I.&L. Al Faruqi, *The Cultural Atlas;* op cit; at p. 320
[1103] R. Briffault: *The Making of Humanity* (London: George Allen and Unwin Ltd, 1928), p 188.
[1104] S.P. Scott: *History*; op cit; vol 3; p. 465.
[1105] W.M. Watt: *The Influence of Islam*; op cit; p. 12.
[1106] F.B. Artz: *The Mind*; op cit; p. 151.

the study of medicine, astronomy, engineering and translation.[1107] There, intellectual debate raged, mostly around religious subjects and issues of jurisprudence.[1108] Two centuries later, in 1065, Artz notes, a great university was founded in Baghdad, and then, in 1234, a second, even more advanced, was set up. This one, he adds, had magnificent buildings, including quarters for four law faculties. The university also maintained dormitories, a hospital, and a huge library, where it was easy to consult the books, and where pens and paper and lamps were supplied free to the students. The students were maintained thanks to endowments.[1109] Similar institutions had also been established at Fes, Al-Azhar in Cairo, at Cordova, and even as far east as in Ghazna, where Sultan Mahmud made the city one of the cultural centres of the orient, amongst other things with a scientific organisation comparable to a university.[1110] The leading institution amongst these, the Qarawiyyin of Fes, was first built in 859, for some time one of the three or four schools of the city, before it became the principal centre of higher learning in Morocco.[1111] It pioneered in providing an advanced curriculum and in its organisation.[1112] Endowed principally by royal families, it received students from near and far, from the Maghrib, the Sahara and also Europe. These students lived in residential quadrangles, which contained two and three storey buildings, accommodating 60-150 students, who all received assistance with food and accommodation.[1113] This Moroccan institution was impressive within and also without. Its dazzling beauty, in architecture and design, is perfectly caught by Burckhardt in all its majesty.[1114]

A predominating trademark of Islamic learning was universality: learning, for the first time in human history, crossed boundaries of class, territory, and social function. In scarcely any other culture, Pedersen holds, has the literary life played such a role as in Islam.[1115] Science, once secluded

[1107] M al-Rammah: The Ancient Library of Kairaouan and its methods of conservation, in *The Conservation and Preservation of Islamic Manuscripts*, Proceedings of the Third Conference of Al-Furqan Islamic Heritage Foundation (1995), pp 29-47. p. 29.
[1108] H. Djait et al: *Histoire de la Tunisie* (le Moyen Age) (Societe Tunisienne de Difusion, Tunis).
[1109] F.B. Artz: *The Mind;* op cit; p.151-2.
[1110] A. Mieli: *La Science Arabe et son role dans l'evolution scientifique mondiale* (Leiden: E.J. Brill. 1938), p. 99.
[1111] B. Dodge: *Muslim Education in Medieval Times* (The Middle East Institute, Washington D.C, 1962), p. 27.
[1112] Ibid.
[1113] Ibid.
[1114] T. Burckhardt: *Fez City of Islam* (The Islamic Text Society; Cambridge; 1992).
[1115] J. Pedersen: *The Arabic Book*; op cit; p. 37.

amongst the few, became 'hobby of the masses, paupers and kings competing to obtain knowledge.' Islam's religious encouragement of science broke the monopolies of the hermits, of churches and temples, say I. and L. Al-Faruqi.[1116] In Al-Qayrawan, women actively participated in the pursuit of learning, and scholars, reigning monarchs and men from all walks of life seem to have supported eagerly the library of their town's grand mosque.[1117] In Muslim Spain, Scott notes, there was not a village where 'the blessings of education' could not be enjoyed by the children of the most indigent peasant, and in Cordova there were eight hundred public schools frequented alike by Muslims, Christians, and Jews, and where instruction was imparted by lectures.[1118] The Spanish Muslim received knowledge at the same time and under the same conditions as the literary pilgrims from Asia Minor and Egypt, from Germany, France, and Britain.[1119] And in the great Muslim university of Cordova, both Jews and Christians attained to acknowledged distinction as professors.[1120]

> 'During the most splendid period of Islamic Spain,' [Scott adds,] 'ignorance was regarded so disgraceful that those without education concealed the fact as far as possible, just as they would have hidden the commission of a crime.'[1121]

Tuition in colleges was free, and in some cases government or philanthropy paid both the salaries of the professors and the expenses of the students.[1122] Caliphs such as Al-Mutawakil (r.847-61), who succeeded Al-Ma'mun (r. 813-833), followed his example, favoured the sciences, and extended protection to men of science, many of whom were Christians; Al-Mutawakil also re-established the celebrated academy and library of Alexandria.[1123] Early Arab authors also give lists of teachers, some of whom taught without remuneration.[1124] However, the thousands of Muslim educational institutions set up between the 7th and 13th century, and even later, were maintained by endowments (waqf), income generating sources

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[1116] I.R. and L.L. Al Faruqi: *The Cultural*; op cit; p.232.
[1117] M.M. Sibai; *Mosque Libraries: An Historical Study* (Mansell Publishing Limited: London and New York: 1987), p 58.
[1118] S.P. Scott: *History;* op cit; Vol 3, at pp 467-8.
[1119] Ibid.
[1120] Ibid.
[1121] Ibid; p. 424.
[1122] Mac Donald: Aspects of Islam; 289; 301 in W. Durant: *The Age of Faith*; op cit; p. 236.
[1123] T. Thomson: *The History of Chemistry*; H Colburn and R. Bentley Publishers (London; 1830), p.113.
[1124] G. Wiet et al: *History;* op cit; p.450.

of one form or another.[1125] In Aleppo, for instance, its is known that a share of the profits from lands and orchards, mills and shops, and baths was devoted to the financing of madrasas (and also mosques and hospitals.)[1126] In Fustat, old Cairo, investments from a number of persons, and also revenues from caravanserais were devoted as waqfs for the up-keep of madrasas.[1127]

At the peak of Islamic civilisation, Pedersen notes, the search for knowledge drove intellectuals to travel widely to hear eminent personages discussing their works.[1128] The teacher counted for more than the text, except in the case of the Qur'an: boys studied men rather than books and students would travel incredible distances to engage the mind of a famous teacher.[1129] Every scholar who desired a high standing at home had to hear the master scholars of Makkah, Baghdad, Damascus, and Cairo.[1130] The many books written about learned men left a strong impression of this intense life of study, which led young and old from one end of the far flung world of Islam to the other.[1131] One person claimed hundreds of teachers, both men and women, and another sold all that he had inherited from his merchant family and spent the money in search of learning; so that he had to travel on foot to Isfahan and Baghdad, carrying his books on his back.[1132] From the Atlantic to the Himalayas the fraternity of scholars thrived.[1133] In many cases the wandering scholar received not only free instruction at the madrasa (college), but, for a time, also free lodging and food.[1134] The great age of Muslim civilization achieved 'a truly lofty ideal of the savant,' concludes Von Grunebaum[1135]

[1125] Such as:
B. Dodge: *Muslim Education in Medieval Times* (The Middle East Institute, Washington D.C, 1962).
K. A Totah: *The Contribution of the Arabs to Education* (New York: Columbia University Press, 1926).
J. Pedersen: *The Arabic Book*; op cit;
[1126] S. Denoix: Bilans: in *Grandes Villes Mediterraneenes;* op cit; p.294.
[1127] D. Behrens Abouseif; S. Denoix, J.C. Garcin: Cairo: in *Grandes Villes Mediterraneenes;* p. 188.
[1128] J. Pedersen: *The Arabic Book*; op cit; p 21.
[1129] W. Durant: *The Age of Faith*; op cit; p. 236.
[1130] Ibid.
[1131] J. Pedersen: *The Arabic Book*; op cit; p 21.
[1132] A.S. Tritton: Muslim Education in the Middle Ages; *The Muslim World*; vol 43; pp. 82-94. at p.92.
[1133] Ibid; p. 20:
[1134] S.K. Bukhsh: Studies; 195 in W. Durant: *The Age of Faith*; op cit; p. 236.
[1135] G.E. Von Grunebaum: *Medieval Islam* (The University of Chicago Press, 1954), p.243.

Islamic civilisation imposed the highest scholarly standards, and it also rewarded them. Whether judge or theologian of Islam, Artz insists, they were required to be experts in Islamic tradition, canon law, and scholastic theology; and the state administrator, the civil servant, and the educated noble or merchant were supposed to be thoroughly trained in grammar, rhetoric, and history.[1136] Among all these professions, facility and distinction in written expression, mastery of etiquette, and a fine command of handwriting were considered great accomplishments.[1137] 'Civilian patterns of human development such as the scholar, the saint, or the literateur have attracted most of Islam's creative energy,' Von Grunebaum says. 'In the social stratification, the civilian outranks the soldier. The vizier, a civil servant, is supposed to have precedence over the general. Governmental theory discusses the vizierate before the generalship. The soldier as a caste has frequently ruled Muslim states, but such de facto supremacy in no way changed the consensus that assigned the state civilian leadership.'[1138] And the highest echelon of social respect was owed to the scholar; a respect that is a frequent topic of Muslim tradition, as Tritton notes:

> 'All creatures lament the death of a scholar, the birds in the air and the fish in the sea, because they profited by his exposition of the law concerning them and his knowledge saved them from ill-treatment. The scholar should not be satisfied in his acts and thoughts with what the law allows: he should aim at the highest. An ignorant teacher is a mockery of religion and to say: 'I do not know' is half of knowledge. To cease learning is to be ignorant.'[1139]

2. Faith, Faiths and Islamic Learning:

The Prophet is quoted as saying:

> 'Acquire knowledge because he who acquires it in the way of the Lord performs an act of piety; who speaks of it praises the Lord;

[1136] F.B. Artz: *The Mind*; op cit; pp. 151-2.
[1137] Ibid.
[1138] G.E. Von Grunebaum: *Medieval Islam*, op cit; p.239.
[1139] A.S. Tritton: Muslim Education in the Middle Ages; op cit; p.82.

> who seeks it, adores God; who dispenses instruction in it, bestow alms; and who imparts it to its fitting objects, performs an act of devotion to God. Knowledge enables its possessor to distinguish what is forbidden from what is not; it lights the way to heaven; it is our friend in the desert, our society in solitude, our companion when bereft of friends; it guides us to happiness, it sustains us in misery; it is our ornament in the company of friends; it serves as an armour against the enemies. With knowledge, the servant of God rises to the heights of goodness and to a noble position, associates with sovereigns in this world, and attains to the perfection of happiness in the next.'[1140]

The Prophet reiterates this message in countless circumstances:

> 'There is nothing greater in the eyes of God than a man who has learned a science and who has taught it to people.'
>
> 'The bearers of knowledge are the successors to the prophets in this world and the martyrs in the Hereafter.'
>
> 'Scholars and teachers are partners in reward, and there are no better people than they.'
>
> 'The knowledge that is not used is like a treasure from which nothing is spent. Its possessor laboured in collecting it, but never benefited from it.'
>
> 'And if God directs you to one single man [who is learned], it is better for you than the whole world and all in it.'[1141]

The acquisition of knowledge, thus, Kramers notes, was in the first place a compliance with a religious command, but at the same time it had to serve the transmission of knowledge to others, and the complete fulfilment of the divine command of 'exhorting to good and admonishing against evil.'[1142] So the scholar was at the same time a teacher, a 'doctor', and his school was that original centre of political and religious life in Islam: the mosque.[1143] There is no branch of Muslim intellectual life, of Muslim religious and political life, of the daily life of the average Muslim that remained untouched by the all pervasive attitude towards 'knowledge' as something of supreme value for the Muslim.[1144]

[1140] Qoted by Syed Ameer Ali: *The Spirit of Islam* (rev. ed.; London, 1922) pp 360-361.
[1141] Ibn Khayr: *Fahrasah;* Ed F. Codera and J. Ribera (Saragossa; 1893; Baghdad; 1963), in A. Chejne: *Muslim Spain;* op cit; p. 175.
[1142] J.H. Kramers: Sciences in Islamic Civilisation. *Analecta Orientalia: Posthumous Writings and Selected Minor Works of J.H. Kramers*; Vol 2 (Leiden; Brill; 1956), p.86.
[1143] Ibid.
[1144] F. Rosenthal: *Knowledge Triumphant;* op cit; p. 2.

'Ilm (science/learning/knowledge),' says Rosenthal, 'is Islam.'[1145]

Religion dominated learning in the Christian world, too: all aspects of society were permeated by religion, the emphasis clearly seen in the intellectual and cultural life of the period.[1146] But there were fundamental differences with Islam.

First, Western education was almost the exclusive province of the clergy. Devons outlines how Grosseteste's disciple, Roger Bacon was the Franciscan 'Dr Mirabilis' of Oxford and Paris; the renowned Albertus Magnus 'Dr Universalis' of Cologne, Provincial of the German Dominican Order and Bishop of Ratisbon. Albertus' disciple, Witelo, was a Silesian Dominican at the Papal court at Viterbo; John of Peckham was Archbishop of Canterbury; Theodoric of Freiberg a Dominican leader of German preachers, etc.[1147] In Islam, in contrast, it was not just that other faiths and groups were part of the intellectual upsurge, but also, and most importantly, the scholars of Islam, with rare exceptions, had no official links with the faith (e.g as Imams, or religious scholars.)[1148]

Secondly, in the Christian West, medieval education, music, art, and architecture were motivated by, permeated with, or channelled into religious goals, and the most highly regarded branch of learning 'the Queen of the Sciences,' as it was called-was theology, the study of doctrines concerning God.[1149] Painting and sculpture dealt mainly with religious subjects; the most magnificent, most costly buildings constructed were churches and cathedrals, and for the medieval period, then, the Latin phrase *ad maiorem Dei gloriam* (to the greater glory of God) was meaningful and relevant for all activities, notes Geanakoplos.[1150] The opposite was the case of Islam. Although God's guidance was always sought, and each and every work opened with the customary 'In the name of God the gracious and merciful,' matters addressed were remarkably endless in scope and diversity. They included all the sciences, as will be extensively shown in the next part, and more importantly, they applied to very practical, earthly matters. Moreover, although faith driven, Islamic learning was not restricted by the faith. It provided absolute freedom to study, a boon which was enjoyed only by

[1145] Ibid.
[1146] D. J. Geanakoplos: *Medieval Western Civilisation, and the Byzantine and Islamic Worlds* (D.C. Heath and Company, Toronto, 1979), p.307
[1147] S. Devons: Optics through the eyes of the medieval Churchmen; in *Science and Technology in Medieval Society*: Edition Pamela O Long: *Annals of the New York Academy of Sciences*, vol 441 (New York, 1985), pp 205-24; at p. 206.
[1148] See entries on Muslim scholars in *Dictionary of Scientific Biography;* op cit.
[1149] D. J. Geanakoplos: *Medieval Western Civilisation,* op cit; p.307.
[1150] Ibid.

those who lived under the shadow of 'the Arab empire.'[1151] Even the Greeks did not accord such freedom as did the Muslims. Did not the Greeks condemn Socrates to drain a lethal draught on the grounds that he was corrupting youth by training them to think? asks Farukh.[1152]

Profoundly affecting the civilisation of Islam is its multi ethnic and multi faith character.

> 'Of all world religions, Islam has been most successful in overriding barriers of colour and nationality. No line is drawn except between believers and unbelievers,' [says Artz.][1153]

Islamic thinking made for a greater mingling of races; there was in it no conception of nationhood as distinct from the religious community.[1154]

> 'For the first time in history,' [says Sabra] 'science became international on a really wide scale and one language, Arabic, became its vehicle. A large number of scholars belonging to different nations and professing different beliefs collaborated in the process of moulding into this one language materials which had previously existed in Greek, Syriac, Persian or Sanskrit. It is this enduring character of the scientific enterprise in medieval Islam which is being emphasised when the phrase 'Arabic science' is used.'[1155]

Arabic science is a misnomer. Indeed, its scholars were mostly non Arabs: Turks, Berbers, Iranians, Spanish Muslims and non Muslims, white and black, and Chinese, too. Even the 'great masters' of the Arabic language were not of Arab ancestry.[1156] Thus, 'Arabic civilisation becomes Muslim civilisation.'[1157]

Islamic civilisation, in its glory centuries, brought together Muslims, Christians and Jews,[1158] all under the mantle of Islam. The Great virtue of the Arabs, Hyams points out, was that they gave the diverse people under their aegis a chance to do their best.[1159] Sarton's prolific *Introduction to the*

[1151] O.A. Farukh: *The Arab Genius in Science and Philosophy* (American Council of Learned Societies, Washington, D.C, 1954), p.10.
[1152] Ibid.
[1153] F.B. Artz: *The Mind*; op cit; p. 140.
[1154] G. Wiet et al: *History*; op cit; p.545.
[1155] A.I. Sabra: The Scientific Enterprise; in *Islam and the Arab World*; ed by B. Lewis (London; 1976), pp. 181-92, at pp. 182-3.
[1156] G.E. Von Grunebaum: *Medieval Islam*, op cit; p.201.
[1157] Ibid.
[1158] S. Pines: *Studies in Arabic Versions of Greek Texts and in Mediaeval Science* (The Magnes Press, Brill, Leiden, 1986), p.354
[1159] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 82.

History of Science is an excellent window on this amalgam of ethnic groups, but most of all on all faiths that met on the Muslim scientific ground.[1160] Commenting on this, he observes:

> 'The great racial and cultural complexity of Islam, even in those early days, is a very curious spectacle. How strong must the religious bond have been to keep together such disparate elements! to begin with, the Abbasid court was entirely permeated with foreign influences-Persian, Jewish, and Nestorians.' [1161]

Again, this tradition of opening up to other faiths goes back to the early example set by the Prophet, and in Islam, Sunni Islam above all, the Qur'an, and the example set by the Prophet are the two guiding principles. Hence, the first Muslim physician we have any record of is Harith Ibn Kalada al-Thakeshi, born near Makkah, who, after practicing medicine for many years in Persia, returned to his native Arabia, and became the friend and physician of the Prophet.[1162] Harith, although the physician of the Prophet, never embraced Islam, and may have been a Christian. This act of the Prophet, Major points out, in selecting an unbeliever as his physician, was doubtless a powerful example to his followers.

Indeed. Islam earliest and most prominent scientists at the Abbasid court, Ishaq Ibn Hunayn and Hunayn Ibn Ishaq were Nestorian Christians. Thabit Ibn Qurrah, the astronomer, was a Sabean. The Bakhishtu family who held most prominent positions in the court in the 9th century were Christians, too, and so was the historian-physicist Abu'l Faraj. So were others of the same profession: Ali Ibn Ridwan, Ibn Djazla of Baghdad, and Isa Ibn Ali. Yaqut al-Hamawi, one of Islam's greatest geographer-historians, was of Greek antecedents, and so was Al-Khazini (the author of the *Balance of Wisdom*). The Jews, as obvious in Sarton's introduction,[1163] in hundreds, had the most glorious pages of their civilisation under Islam, too. From Maimonides to Hasdai Ibn Shaprut, to Petrus Alfonsi, to the Ben-Tibbons, all reached fame and prominence under Islam. Draper observes that in Cordova, Granada and other large cities, the universities were frequently under the superintendence of Jews because, for the Muslims, the maxim was that 'the real learning of a man is of more public importance than any particular religious opinion he may entertain,' a liberality, Draper notes, in striking contrast with intolerant Europe.[1164]

[1160] G. Sarton: *Introduction*; op cit.
[1161] Ibid; vol I, at p.524.
[1162] R.H. Major: *A History of Medicine*; 2 vols (Blackwell; Oxford), Vol 1; p. 229.
[1163] G. Sarton: *Introduction;* op cit.
[1164] J.W. Draper: *A History of the Intellectual Development*, op cit; vol 2; p.36.

There seems to be a major deficiency in the multi-ethnic character of Islamic civilisation, though, as Sarton points out:

> 'Although the Persians had introduced into the Caliphate a greater love of beauty, urbanity, intellectual curiosity, and much fondness for discussion, all favourable to the progress of science, free thought was often followed by libertinage and immorality. No wonder that the genuine Arabs looked down upon the Persian intruders even as the old Romans looked down upon the Greeks. The fact is that every civilisation acts as a poison upon those who have not been properly inoculated; it would act that way even were it perfectly pure and did not contain (as it always does) evil elements. The Arabic strength and virtue were gradually undermined by Persian urbanity.'[1165]

Sarton's point, that the Persians undermined Arabic strength, somehow runs against the opinions of those who grant the Persians all good part in the Islamic civilisation. In response to Sarton's point, the undermining of Arabic strength lies not in this Persian intrusion nor in the so called Turkish intrusion nor in the Berber intrusion (all sorts of intrusions and their impact will be examined in the final part of this work). All these ethnic groups, Persians, Turks, Berbers etc, had their points of strengths and weaknesses. They gave Islam and Islamic civilisation a huge amount, but not everything. The Muslims became corrupt in urbanity, their harems and the like, not just where the Persians had an influence, but all over the Muslim world, even in Muslim Spain, which had little Persian influence in its midst. As for the maligned Berbers and Turks, it was they who fought the most decisive battles that saved the Islamic world from the crusaders and Mongols. The real, the true intrusion that truly destroyed Islamic civilisation was the 13th century combined Crusade-Mongol concerted push, one from the east and the other from the west.[1166] This assault did not just cause destruction, slaughter and mayhem; it led above all the Islamic realm to alter its priorities: fighting for survival, instead of scholarly creativity. This matter will be returned to in great detail in the final part of this work.

[1165] G. Sarton: *Introduction*; op cit; p.524.
[1166] See, for instance,
-Baron G. D'Ohsson: *Histoire des Mongols;* op cit.
-J.J. Saunders: *Aspects of the Crusades* (University of Canterbury Publishing; Canterbury; 1962).
-P. Pelliot: *Mongols and Popes; 13th and 14th Centuries* (Paris; 1922).

3. The Place of Arabic:

> 'Islam, and also the Arabic language,' [Jurji insists,] 'are the two ostensible factors in the creation of that gigantic melting pot in the centre of whose orbit rose the scientific leaders of the Arabic speaking world.'[1167]

This international community of letters was made possible, indeed, by the fact that throughout the Islamic world-whatever its diversity of peoples-the language of learning and literature was Arabic.[1168] Arabic, the language of Revelation, of diplomacy and polite intercourse, thus becoming that of science.[1169] From the end of the 8th century to the end of the 11th the intellectual leaders had been mostly Muslims, according to Sarton, and the most progressive works had been written in Arabic: during these three centuries the Arabic language was the main vehicle of culture.[1170] As Von Ranke observes, leaving Latin aside, Arabic is the most important of all the languages of the world for universal history.[1171] The language that ranks so high 'for purposes of eloquence and poetic flight' lent itself to the demands of exact and positive expression.[1172] Sapir, in his *Language*, lists it as the third among those which have had an overwhelming significance as carriers of culture. English and French are conspicuous by their absence from this list. Montgomery, in the *Haverford Symposium*, also asserts that Arabic has had the most unique development and spread of all the tongues of the earth and that only within the last two centuries has English come to rival it.[1173] Archer,[1174] goes further, asserting that Arabic is a richer and more flexible tongue than Latin or Greek, no Western tongue equalling it in the variety of its forms and verbal nouns.[1175]

A great number of scholars contributed to the emergence of Arabic as a powerful tool of communication, and one of them was Ibn Sidah. Ibn

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[1167] Edward J. Jurji: The course of Arabic Scientific Thought: in *The Arab Heritage;* Edition: N.A. Faris (Princeton University Press, 1944), pp 221-50; at p. 221.
[1168] W. Durant: *The Age of Faith*; op cit; p. 236.
[1169] Edward J. Jurji: The course; op cit; p.224 .
[1170] G. Sarton: *Introduction*; op cit; Vol II, p.109.
[1171] P.K. Hitti: America and the Arab heritage; op cit; p.5.
[1172] E J. Jurji: The Course; p. 222.
[1173] P.K. Hitti: America; op cit; p.5.
[1174] John C. Archer: Our debt to the Moslem World', *The Moslem World*, XXXIX (1939), p. 259.
[1175] P.K. Hitti: America; op cit; p.5.

Sidah was one of the prominent philologists of the 11th century, and he had a great influence on Arabic lexicography.[1176] He was born blind in Murcia, and received his early education from his father. He developed a fantastic memory, which aided him in compiling voluminous lexicons.[1177] His lexicon, *al-Muhkam,*[1178] was arranged alphabetically, each letter constituting a section divided into chapters, each entry explained, giving, for instance, the verb, its imperfect, verbal nouns, and derivatives.[1179] *Al-Muhkam* was followed by a larger work, *al-Mukhassas.*[1180] In this, Ibn Sidah provides a long discussion of various aspects of the language, mainly the excellence and the origin of language.[1181] He takes a middle position between those who advocate divine origin of language and those who held that language resulted form human convention. He maintained that he had pondered this question for a long time and found that each of the opposing views had some convincing arguments, but he concluded that Arabic is so noble, perfect, and elegant that God must have helped to make it so through His teaching and inspiration.[1182]

The evolution and development of Arabic into a language of religion, state and culture constitutes the most fascinating chapter of Arab history.[1183] During the rise of Islam in the 7th century, Arabic was basically a tribal language lacking a written grammar, lexicon and the terms of the sciences as they were known in the great urban centres of the Near East.[1184] However, soon after the expansion of Islam over a wide territory, including the area from the Indus River to the Atlantic Ocean, special care was taken to study the language in which the Qur'an was revealed and to preserve its purity in conformity with the Holy Book, pre-Islamic poetry and Bedouin speech as it was known in and around the city of Makkah.[1185] This interest in the language eventually led to intensive

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[1176] On Ibn Sidah, See Ibn Bashkuwal: *Al-Silah*; ed by Fr Codera (Madrid; 1882-3); ed Izzat al-Itar al-Hussayni; 2 vols (Cairo; 1955), vol 2; pp. 396 ff; See also J. Haywood: Arabic Lexicography; op cit; pp 66 ff.
[1177] A. Chejne: *Muslim Spain*; op cit; p. 191.
[1178] Ibn Sidah: *Al-Muhkam wa'l muhit al-a'zam* (Cairo; 1958).
[1179] A. Chejne: *Muslim Spain*; op cit; p. 191.
[1180] *Al-Mukhasas;* 17 pts; Edition Bullaq (1316-1321 (H).
[1181] A. Chejne: *Muslim Spain*; op cit; p. 191.
[1182] Ibn Sidah: *Al-Mukhassas;* op cit; pp. 3-6.
[1183] For the rise and role of Arabic, see A. Chejne: *The Arabic Language: Its role in History* (Minneapolis; 1969).
[1184] A. Chejne: *Muslim Spain;* op cit; pp. 182-3.
[1185] Ibid.

linguistic studies, which comprised not only grammar and lexicography but every aspect of the language.[1186]

There were positive factors which helped to give impetus to Arabisation, and which are outlined by Chejne.[1187] Although the newcomers (the Arabs) were the minority, their numbers increased through marriage, principally, and their offspring became Muslims and learned the languages of both father and mother. As the numbers of converts to Islam increased, the Arabic language came to have a wider significance and served as the medium of unity among Muslims, first, and among these and non-Muslims afterward. The Umayyad, who were proud of their Arab ancestry, and who came to rule the land of Islam after the first four caliphs (from roughly 661 to 750), also made Arabic the official language. Their rule over Muslim Spain from roughly the 750s to 976, also played a part in spreading the language there. From the 9th century onward, Arabic increasingly became the language of daily communication and the instrument of literary expression for Muslims and non Muslims.[1188]

How Arabic rose to a prominent role so as to become the vehicle of science and culture is elaborated upon by Sarton:

> 'The vehicle of the new Muslim civilisation was a language that had never been used for any scientific purpose. Almost every bit of knowledge had to be translated either from Greek or from Sanskrit, or from Pahlawi before it could be assimilated. And not only that, but these interpretations necessitated the creation of a philosophic and scientific terminology, which did not exist. When one takes all this into consideration, instead of being surprised at the relative smallness of the first harvest, one cannot help admiring the immensity of the effort. This effort was of such a nature that no people could have endured it for a long time, but only during a period of exaltation and youthful optimism.'[1189]

Hence a double accomplishment, not just in turning a non scientific language into one upon which modern science was built but also in acting as the crucial unifying element of so many disparate nations and groups. Without such a language, uniform through a vast land, little progress in science would

[1186] For general works on Arabic philology, see: Ibn Faris: *Al-Sahihi fi fiqh al-lughah* (Cairo; 1910); Al-Suyuti: *Al-Muzhir* (Cairo; 1958); A Gonzales Palencia: *Historia de la Literatura arabigo-espanole* (Barcelona; 1928); J. Haywood: *Arabic Lexicography* (Leiden; 1960).
[1187] A. Chejne: *Muslim Spain*; op cit; pp. 184-5.
[1188] Ibid.
[1189] G. Sarton: *Introduction* vol I, at p.523.

have happened, except in insignificant pockets. This is also the first instance of universality of the language of science, and it was possible thanks to the Arabic language itself. The primary role of Arabic is its semantics, its flexibility enabling the scholar to coin exact scientific and technological vocabularies 'capable of expressing the most complicated scientific and technical ideas.'[1190] Arabic is also exceedingly rich, and it can be increased almost indefinitely, because a very complex and elegant morphology makes it easy to create new derivatives.[1191] Reflecting this dominance of Arabic in the scientific field, words of Arabic origin are very numerous in the scientific sphere: almost all the names of constellations and the basic terms of astronomy, for instance, come from Arabic, as Erbstosser notes.[1192] Much the same is the case for other sciences, as the next part highlights, and such was the place of Arabic in the scientific-cultural medieval outburst, that not just the translators of sciences (Gerard of Cremona, Robert of Chester, John of Seville…), but every single man of learning of Western Christendom had to be knowledgeable in it. Arnold of Villanova (d.1311), for instance, mastered Arabic, and in his enthusiasm for Islamic medicine translated a series of its important works into Latin.[1193] The role of Arabic reached even further, Arabic symbolising all that was sophisticated, and superior; 'material wealth and comfort for Western Europeans, must have at times appeared to go hand in hand 'with the ability to read Arabic,' Menocal points out.[1194] Thus, with great bitterness, the Christian figure, Alvarus (9th century), conceded:

> 'Who is there among the faithful laity sufficiently learned to understand the Holy Scriptures, or what our doctors have written in Latin? Who is there fired with love of the Gospels, the Prophets, the Apostles? All our young Christians… are learned in infidel erudition and perfected in Arabic eloquence. They assiduously study, intently read and ardently discuss Arabic books…. The Christians are ignorant of their own tongue; the Latin race does not understand its own language. Not one in a thousand of the Christian communion can write an intelligent letter to a brother. On the other hand there are great numbers of

[1190] A. Y. Al-Hasan; D.R. Hill: *Islamic Technology* (Cambridge University Press, 1986, p 10:
[1191] G. Sarton: *The Incubation of Western Culture in the Middle East*, A George C. Keiser Foundation Lecture, March 29, 1950 (Washington; DC 1951), p.19.
[1192] M. Erbstosser: *The Crusades;* op cit; p. 185.
[1193] R. I. Burns: Muslims in the Thirteenth Century Realms of Aragon: Interaction and Reaction, in *Muslims under Latin Rule, 1100-1300;* J.M. Powell: editor (Princeton University Press, 1990), pp 57-102; at pp.90-1.
[1194] M R Menocal: *The Arabic Role in Medieval Literary History* (University of Pennsylvania Press, Philadelphia, 1987), p.63.

them who expound the Arabic splendour of language, and metrically adorn, by mono-rhyme, the final clauses of songs, better more sublimely than other peoples.'[1195]

'We can only express our wonder and 'say mashallah' (God willed it),' [comments Sarton,] 'how it so happened (and this the Prophet could not foresee unless he had some divine insight) that the only language he knew was one of the most beautiful languages in existence.'[1196]

4. The Scope and Accomplishments of Muslim Scholarship:

The success of the Muslim renaissance, Sarton holds, was 'essentially due to the wave of enthusiasm and energy which lifted these people up for a time almost above themselves.'[1197]

The life and works of the poet Abu'l Ala al-Ma'ari, briefly summarised by Durant, are quite edifying.[1198] Abu ala al-Ma'ari (10th-11th centuries) was born at al-Ma'arat, near Aleppo. Smallpox left him blind at the age of four; nevertheless he took up the career of a student, learned by heart the manuscripts that he liked in the libraries, travelled widely to hear famous masters, and returned to his village. During the next fifteen years his annual income was thirty dinars (some twelve dollars a month), which he shared with servant and guide; his poems won him fame, but as he refused to write encomiums, he nearly starved. In 1008 he visited Baghdad, was honoured by poets and scholars before returning two years later to Ma'arat, became rich, but lived to the end with the simplicity of a sage. He was a vegetarian a l'outrance, avoiding not only flesh and fowl, but milk, eggs, and honey as well; to take any of these from an animal world, he thought, was rank robbery. On the same principle he rejected the use of

[1195] Alvari Cordubensis Indiculus Luminosus in Migne, *Patrologia Latina* 121, cols. 555-6. Quotation in English from R. Dozy: *Spanish Islam: a History of the Muslims in Spain;* tr: F.G. Stokes (London; 1913), p. 268.
[1196] G. Sarton: The Incubation; op cit; p.19.
[1197] G. Sarton: *Introduction*, vol I, at p.549.
[1198] W. Durant: *The Age of Faith*, op cit; p.265:

animal skins, blamed ladies for wearing furs, and recommended wooden shoes.[1199] He died at eighty four; and a pious pupil relates that 180 poets followed his funeral, and eighty four savants recited eulogies at his grave.'[1200]

A similar picture, but at the level of royalty, is illustrated by the life of Abd Errahman III of Spain (r.912-961).[1201] As a ruler, he fought and quashed the threats to the kingdom; from within and from without. Under his rule, commerce thrived and so did agriculture, horticulture and industrial production. His contribution to arts, learning, and civilisation was enormous and he was also known for his building of the famed al-Zahra (the Bright One) at Cordova. The mosques, schools, baths and gardens and scholarly circles of his time were only rivalled by those of Baghdad.[1202] Then, Abd Errahman virtually abandoned the administration of the empire to his heir, Al-Hakem II. He renounced the frivolities of the court and attached himself to the ascetic Abu Ayub, in whose company he passed much of his time in fasting, prayer, and the distribution of alms. He focused his mind on learning and reading, drawn to intellectual curiosities of various sorts. After the king's death, in a journal which recorded his most secret thoughts, were found his reflections on 'the disappointments of life and the delusive attractions of human greatness and imperial ambition':

> 'I have reigned fifty years in peace and in glory, beloved by my people, feared by my enemies, respected by my allies. My friendship has been sought by the great kings of the earth. I have wanted nothing that the heart of man could desire, -neither renown, nor power, nor pleasure. During this long life, I have counted the days when I have enjoyed complete happiness- and they amount to only fourteen! Praise be to Him who alone possesses eternal glory and omnipotence, there is no other God than He!'[1203]

Abd Errahman's predilections for a sedentary life, and his intimate relations with the learned,' Scott points out, 'were viewed with contempt

[1199] Nicholson: Islamic poetry; 133-7 in W. Durant: *The Age of Faith*, op cit, p. 265.
[1200] A.F. Rihani: The Quatrains of Abu'l Ala (Al-Maari); vii; in W. Durant, op cit, p.265.
[1201] Extracts from:
-E.L. Provencal: *Histoire;* op cit.
-S.P. Scott: *History*; op cit.
- S and N. Ronart: *Concise Encyclopaedia of Arabic civilization; The Arab West* (Djambatan; Amsterdam; 1966).
[1202] S and N. Ronart: *Concise; op cit;* p.15.
[1203] S.P. Scott: *History*; op cit; vol 1; pp 632-3.

by the barbarous Christians, who considered war as the peculiar calling of a man of spirit, and the acquisition of knowledge as only fit for monks, an order whose pacific occupations did not, nevertheless, exclude even its members from the profession of arms.'[1204]

Another figure from the scholarly world gives the same impression. Abbas Ibn Firnas (d.887) of Cordova had such a boundless imagination and inventive faculty, he could decipher even the most incomprehensible hieroglyphics.[1205] On one occasion, as Levi Provencal narrates:

> 'When a merchant returned to Spain with Khalil's treatise on the Arab metrical system, nobody could make anything of these rules of prosody and scansion. Abbas had the manuscript brought to him, and betook himself with it to a corner of the palace, where he examined it and, quickly grasping its meaning, proceeded to explain it to a dumbfounded audience.'[1206]

Ibn Firnas was also a poet under three successive rulers, a mathematician, an astronomer and physicist. He built his patrons a mechanical clock and an armillary sphere (a combination of metal rings representing the sky and the movements of astral bodies).[1207] He is also credited of having imported the Arabic numeral system after a trip to Iraq.[1208] Ibn Firnas also invented spectacles, complex chronometers, and a flying machine.[1209] He was accustomed with the scientific properties of glass, and contributed to early experiments with lenses and the idea of magnifying script by their use.[1210] He also lent his skills to the glass making furnaces of Cordova, and made a representation of the sky in glass, which he was able at will to make clear or cloudy, with lightning and the noise of thunder at the press of a finger.'[1211] He also made some of the earliest attempts at flying by building artificial wings.[1212]

More extraordinary figures could be added, but one principal element common to many was their monumental written output. It was not just the better known figures of Ibn Sina or Al-Razi, whose works *The Qanun* and *The Continens* were so voluminous they were never edited whole, or kept

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[1204] Ibid; vol 1; at p.638.
[1205] L. Provencal in G. Wiet et al: *History;* op cit.p.455.
[1206] Ibid.
[1207] S. N. Ronart: A *Concise*; op cit; p. 142.
[1208] Ibid.
[1209] W. Durant: *The Age of Faith*; op cit; pp 298.
[1210] A. Djebbar: *Une Histoire;* op cit; 272-4.
[1211] Levi Provencal, in G. Wiet et al: *History*; op cit; at p.336.
[1212] A. Djebbar: *Une Histoire;* op cit; p. 274; S and N. Ronart ed: *A Concise*; op. cit; at p. 142.

in one location, but many others slightly lesser known. Thus, Ibn Hayyan of Cordova (b.987-88 d. 1076), not to be confused with the earlier chemist, Jabir Ibn Hayyan, was the author of an immense history of Spain in 60 volumes (*Kitab al-matin, Liber solidus*) and of a shorter work, in 10 volumes, dealing with the biographies of Hispano-Muslim scholars (*Kitab al-Muqtabis fi Tarikh al-Andalus*).[1213] Ibn al-Khatib of Cordoba, who died in the 10th century, is credited with nearly 1100 works on metaphysics, history, and medicine, whilst Ibn Hassan composed 450 books on philosophy and jurisprudence.[1214] Ibn Hazm (994-1064) lived for a considerable length in Xatiba, near Valencia, and in the Algarve, and died there; his writing included around 400 volumes, nearly 80,000 pages.[1215] Al-Tabari, born in 839, in Amul, in the province of Tabaristan, which gave him his surname, commenced his studies in Amul, he then left for many cities: Ravy, Baghdad, Basra, Kufa, different Syrian centres of learning, then Fustat in Egypt, then back to Baghdad.[1216] Al-Tabari, according to Yaqut (d. 1229), had planned a commentary on the Qur'an ten times more voluminous than the one he completed that is 30,000 pages rather than 3,000. It was only the anguished protests of his pupils that led him to smaller number.[1217] Al-Tabari is also said to have projected the precise number of pages for his universal history, 30,000 only to reduce that to the same 3000, because of the same youthful protests.[1218] Yaqut al-Hamawi himself managed altogether 33,180 pages on the poets and men of literature,[1219] whilst Al-Marzubani, who died shortly before the year 1000, wrote over 37,580 pages, according to Ibn al-Nadim's *Fihrist.*[1220] According to the catalogue established by Al-Biruni (973-1050), the writing by al-Razi (854-934-5) can be classified as follows: 56 medical works; 33 works on natural sciences; 8 on logic; 10 on mathematics; 17 on philosophy; 6 on metaphysics; 14 on theology; 23 on chemistry; 10 on varied subjects; and 7 on explanations or summaries of other philosophical or medical works.[1221] Ibn al-Jawzi, an encyclopaedist (b. ca. 1115-d. 1201), was one of the most learned men of his time, and his immense literary activity was equalled in Islam only by al-Suyuti's (second

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[1213] G. Sarton: *Introduction,* vol I, op cit; p.734.
[1214] S.P Scott: *History;* op cit; vol 3 p. 425;
[1215] A. Mieli: *La Science Arabe;* op cit; p.183.
[1216] J. Dahmus: *Seven Medieval Historians* (Nelson-Hall, Chicago, 1982), p.83.
[1217] Ibid; p.85.
[1218] Ibid.
[1219] Yaqut al-Hamawi: *Irshad al-arib ila marifat al-adib*, also referred to as *Mu'ujam al-udaba*, edited by D. S. Margoliouth (London, 1907-1926) V, 110. Yaqut is also the author of a geographical encyclopaedia: *Mu'jam al-Buldan* (Dictionary of countries).
[1220] Ibn al-Nadim: *Al-Fihrist* pp 132-4 in J. Pedersen: *The Arabic Book*, op cit, p. 37.
[1221] A. Mieli: *La Science Arabe;* op cit; p.91.

half of the 15th century.)[1222] His almost innumerable writings treat of history, philology, biography, Hadith, Fiqh, the Qur'an, ethics, medicine, geography, etc. His most important work seems to be a history of the world from the creation to 1180, entitled *Kitab al-muntazam wa multaqat al-multazam*. He prepared a critical edition of al-Ghazzali's *Ihya*. He wrote a treatise on medical generalities called *Luqat al-manafi fi'l-tibb*, and another on spiritual medicine, *Kitab al-Tibb al-Ruhani*. Also a sort of autobiography in the form of a letter to his son, *Liftat al-Kabid*, followed by a list of his writings, he compiled two other lists of these.[1223] Ibn al-Banna, also known as Abu'l-Abbas Ahmad ibn Muhammad ibn Uthman al-Azdi, was born in 1256 in the city of Marrakech, or the region of Marrakech.[1224] Al-Banna wrote a large number of works, in fact 82 are listed by Renaud.[1225] Based on the inventory that was made at the time by Ibn Hayder, Ibn al-Banna seems to be in fact the author of more than 100 titles, of which 32 concern Mathematics and Astronomy, the others being dedicated to disciplines very distant from each other, like Linguistics, Rhetoric, Astrology, Grammatics and Logic.[1226] Al-Nuwayri (1279-1332), a close associate to the Mamluk Sultan al-Nassir, was deeply interested in the art of writing, writing eighty pages a day, completing an encyclopaedia entitled *Nihayat al-arab fi funun al-adab*, which aimed at encompassing all sociological sciences needed for the prominent secretaries.[1227] Pursuing the tradition, Ibn Khaldun's (1332-1406) *Muqqadimma* was not just immense in size, but also dealt with many subjects, covering subjects ranging from history, to political administration, economic and social institutions, etc.[1228] And, of course, the sheer number of scholars themselves is quite impressive, Hammer Purgastall counted 5,218 Muslim authors who lived and wrote prior to the end of the 11th century.[1229] In his *Geschichtschreiber der Araber*,

[1222] G. Sarton: *Introduction*; Vol II, p.362.
[1223] Criticism: Ibn Khalikan: Biographical Dictionary; Tr MacGukin de Slane; 6 vols (Paris-London; 1843); vol 2, 96-98, L. Leclerc: *Medecine Arabe;* vol 2, 36, (1876). F. Wustenfeld: *Geschchtschreiber der Araber*, 102-104 (1881). All in G Sarton: *Introduction*; Vol II, p.362.
[1224] J J O'Connor and E F Robertson: *Arabic Mathematics, a Forgotten Brilliance* at: http://www-history.mcs.st-andrews.ac.uk/history/index.html
[1225] Ibid.
[1226] Al-Balagh and Djebbar, 1995b, in A. Djebbar: Mathematics in Medieval Maghreb; *AMUCHMA-Newsletter* 15; Universidade Pedagógica (UP), (Maputo Mozambique, 15.9.1995).
[1227] I.J. Krckovskij: *Izbrannye Socinenja* (chosen works); Vol 4 (Moscow, 1957), pp. 439-42.
[1228] Ibn Khaldun: *The Muqqaddimah*, tr. F. Rosenthal; 3 vols (New York, 1958).
[1229] S.K. Bukhsh: 'The Islamic Libraries.' *The Nineteenth Century and After*' (July 1902) 125-39. p. 127 (there is unfortunately no figure for the period after that date, especially in the 12th – 13th centuries.)

written in 1882, Wustenfeld counted no less than 590 historians who flourished in the first thousand years of Islam.[1230]

> 'Out of their different circumstances of life,' [Jurji observes,] 'the wielders of the new scientific style travelled their numerous pathways till they met together at a single crossroad. Common to most of them was the unwearied attempt to simplify and to make lucid. Herein resided their own unchallengeable genius. They could, despite certain persistent opinions to the contrary, make generalizations and propound a subtle synthesis. They had a solid mastery over their materials, necessary in creative work. They could classify and enumerate, above all, they possessed untarnished the simple gift of orderliness.'[1231]

Organising, systematising, and classifying sciences was indeed a shared preoccupation of Muslim scholars, from Al-Farabi to Al-Ghazali, Ibn Sina, Ibn Hazm, and many more. Al-Farabi's *Ihsa al-Ulum* (Catalogue of the Sciences, ca 900) was widely used by Muslim authors as an introduction to philosophical study and was twice translated into Hebrew, and into Latin in the 12th century by Gerard of Cremona.[1232] The preface offers a classification of all the recognised sciences, or branches of learning, their parts, and their contents.[1233] Al-Farabi identifies five major sciences: grammar, logic, mathematics, the science of physics and metaphysics, and political science, which includes the Islamic religious disciplines of jurisprudence (*fiqh)* and dialectical theology (*kalam*).[1234] The preface concludes with some remarks on the purpose and utility of such an enumeration:

> 'It will indicate the proper beginning and order of the study of the sciences and will orient the student to the study he is about to undertake; it will show him the relative value of various disciplines; and it will alert him to those who profess expertise in some or all of the sciences but who are in fact charlatans.'[1235]

Prior to such classifications, sciences were a bulk of knowledge, where the scientific mingled with the folkloric, which was very obvious with both Greek and early Islamic learning. It was thus very common to find the chemist dabbling with the magician, and it was extremely hard to

[1230] P.K. Hitti: America and the Arab heritage: in *The Arab Heritage*, op cit; pp. 1-24; p.5.
[1231] E. J. Jurji: The Course; op cit; pp. 222-3.
[1232] D.L. Black: Al-Farabi in Medieval Philosophers; *Dictionary of Literary Biography;* Vol 115; Edited by J. Hackett; A Bruccoli Clark Layman Book; Detroit; pp. 184-95. p.189.
[1233] Ibid.
[1234] Ibid.
[1235] Ibid.

delimit the boundaries, or prevent the non scientific taking over the scientific. Sciences also had no distinct parameters within which they could be addressed. The Islamic classification of sciences thus somehow refined the whole matter, contributing to the emergence of what was centuries later to be our modern learning system in departments, faculties, and courses. And then, within the sciences, further subdivisions were made. Al-Razi and Jabir Ibn Hayyan (722-815) performed it to perfection in chemistry. In his work *Secret of Secrets*,[1236] Al-Razi, for instance, divided natural substances into earthly, vegetable and animal substances, to which he also added a number artificially obtained such as lead oxide, caustic soda, and various alloys. Al-Razi again, in his medical treatises gathered all knowledge, formerly disorganised, into a perfect synthesis, thus providing his users with a framework for learning, understanding, and developing medical subjects.[1237]

The benefits of the dictionary are too well established to warrant any praise, but praise is due to Islamic scholarship, which brought us dictionaries in every form and format. Islamic biographical dictionaries, for instance, as Young observes, combine and also anticipate the features of both Who's Who and works such as the *Dictionary of National Biography*.[1238] Biography, Young explains, seeks to understand the individual and those features of character that make them unique, the space devoted to each being proportional to their importance. The most frequent matters included in the entries are the subject's date of death, their lineage, education and travels; appointments, their intellectual and moral qualities and interesting anecdotes related to them. Also included are philological notes on the form of the subject's name, a brief description of their physical appearance and, in the case of authors, a list of their works.[1239] The earliest biographical dictionary was the *Kitab tabaqat al-muhaddithin* of al-Mawsali, who died in 800, but of which no copy is thought to have survived. Many more followed, and included not just the names of men but also of women; encompassing all classes of important people, as in such works as *Kitab Wulat Misr was qudatiha* (Book of the Governors and Judges of Egypt) by Muhammad b. Yusuf al-Kindi (d 961) and *Qudat Qurtuba* (The Judges of Cordova) by al-

[1236] Translated into Latin by Gerard of Cremona in the 12th century; see chapter on sciences, and chemistry section.
[1237] See chapter on sciences and section on medical sciences..
[1238] M.J. L Young: Arabic Biographical Writing. in *Religion, Learning and Science in the Abbasid Period,* Ed M.J. L. Young, J.D. Latham and R.B. Serjeant (Cambridge University Press, 1990), pp 168-187; p. 173.
[1239] Ibid.

Khushani (981).[1240] The Fihrist, completed by the Baghdad bookseller, Ibn al-Nadim, in 987,[1241] gives the most detailed account of all works by Muslim scholars up to the last decade of the 10th century.[1242] It is divided into ten 'discourses' the first, for instance, describing the language of both Arabs and non Arabs, the varieties of their scripts etc. The second mainly deals with grammar; the third with *Belles Lettres*, biography, genealogies etc. From al-Fihrist the scale of loss of Islamic works becomes obvious, for the majority of works it cites are no longer extant.[1243] Ibn al-Asqalani in his *al-Durar al-kaminah*, has over 5000 entries, while al-Athir in his *Usd al-ghalab fi maarifat al-sahabah* has over 7000.[1244] The most used Islamic Biographical sources are those of Ibn-al-Qifti (d.1248), who wrote *The History of the Philosophers* on the lives of 414 philosophers and scientists; Ibn-Abi-Usaybi'ah, who wrote the *Tabaqat al-Atibba'* (The Classes of the Physicians) (1242), and the bibliographer Hajji Khalifa (d.1658) whose work contains 18,500 indications of Oriental works, with the names of the authors and a bibliography of each of them.[1245] Ibn Khallikan (1211-1282) in his *Wafayat al-ayan* (Obituaries of Men of Note), wrote brief anecdotal lives of over 850 distinguished Muslims.[1246] Whilst Durant finds the work remarkably accurate, Ibn Khallikan nevertheless apologised for its imperfections:

'God has allowed no book to be faultless except the Qur'an.'[1247]

The search for maximum accuracy was a constant concern in the endeavours of Islamic scholarship. So keen were biographers, for instance, to achieve accuracy that persons bearing the same name had whole books devoted to them, one such book being The *Kitab al-Mushtabih fi asmaa al-rijal* (Book of Names of Authorities Resembling Each Other) by al-Dhahabi (d.1348). Biographers also went to great lengths to differentiate between degrees of certainty, near certainty and doubt. Abd al-Ghani Hasan, hence, mentions the method of Yaqut in his *Irshad al-Arib,* whereby 'he does not state something positively when he is not certain; only using 'I think', 'I reckon', and similar expressions

[1240] Ibid.
[1241] R.P. Multhauf: *The Origins of Chemistry;* op cit; p.124.
[1242] B. Dodge: *The Fihrist of al-Nadim.* A Tenth Century Survey of Muslim Culture, Columbia Records of Civilisation: Sources and Studies, No LXXXIII, 2 Vols (New York and London; 1970).
See also M. Nakosteen, History... op cit, for extracts from *al-Fihrist*, pp 29-33.
[1243] B. Dodge: *The Fihrist;* op cit.
[1244] M.J. L Young: Arabic Biographical Writing; op cit; at p.169.
[1245] G Le Bon: *La Civilisation;* op cit. p. 358.
[1246] W. Durant: *The Age of Faith*; op cit. p.319.
[1247] Ibid.

indicative of mere supposition. On the other hand, when confident about the matter, he says: 'that which I know is', 'that with which I am acquainted is' and similar phrases indicative of certainty.[1248] This keen search for accuracy follows on the legacy of Imam al-Bukhari. Al-Bukhari (b. 810) travelled the length of the land of Islam, and for years, in search of accurate texts of tradition, selecting the 7,275 most trusted Prophet's sayings out of an initial total of 300,000 of a more doubtful or spurious character.[1249] All were classified according to the chapters of common law, and helped form a complete system of concrete jurisprudence. This approach was the earliest example of such critical activity in the world, with remarkably high standards of accuracy.[1250] Such accuracy relied on an earlier oral tradition: recitation. Recitation alone gave the certainty of avoiding confusion, and in the words of Shwab, for whom oral transmission was the method of high fidelity as compared with 'the professional blunderings of never ending copyists', the more so in view of the 'heights of perfection long ago attained in memorizing techniques'.[1251]

Islamic learning also distinguished itself in striking the perfect balance between authority and experiment. Ibn Hazm comments on reliance upon authority:

> 'We know with certainty that never could man have acquired the sciences and arts by himself guided only by his natural abilities and without the benefit of instruction (this applies, for instance,) to medicine, the knowledge of the physiological temperaments, the diseases and their causes, in all their numerous varieties, and the invention of adequate treatment and cure of each of them by drugs or preparations, which could never have been actually tried out. For how could anyone test every prescription on every disease since this would take thousands of years and necessitate the examination of every sick person in the world? And what goes for medicine goes for other sciences.'[1252]

The trust in authority, however, is balanced against the need for proof and experiment. For a long time, Jurji notes, interpretation was the Muslim's legitimate monopoly. 'Soaring high above the mean levels of confusion'

[1248] *Al-tarajim wa'l siyar*, 84, In M.J.L. Young: Arabic; op cit, p.178.
[1249] E. Gibbon: *The Decline;* op cit; chap L; part iv.
[1250] Ignaz Goldziher: *Progress of Islamic Science*; St Louis Congress of Arts and Sciences, vol 2, 497 sq., 502 (1906).
[1251] In G. Wiet et al: *History*; op cit; p.446.
[1252] *Kitab al-fisal fi'l-milal*, I, 72. In G. Le Bon: *La Civilisation;* p. 329.

they did not seem satisfied till full proof and concrete evidence had been meticulously offered in their writings.[1253] Thus, for al-Maqdisi:

> 'He (the scholar) should not yield to bad habits or permit himself to be led astray by vicious tendencies. Nor must he turn his eyes from truth's depth. He should discriminate between the doubtful and the certain, between genuine and spurious, and should always stand firm by the clear light of reason.'[1254]

Checking, measuring, and experimenting to determine truth were thus central to Islamic learning, and affected all branches of sciences. Ibn al-Haytham (965-1039), for instance, was able to determine optical rules through experimentation rather than the speculative exercise current before him.[1255] Muslim astronomers devised astronomical tables through observations and calculations, and using for the first time sophisticated apparatus for such operations.[1256] In chemistry, the pioneering role in this goes to Jabir:

> 'The first essential in chemistry is that you should perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery. But you, O my son, do you experiment so that you may acquire knowledge.'[1257]

Scientists delight not in abundance of material; they rejoice only in the excellence of their experimental methods.'[1258]

And beautiful lines from al-Zamashhari:

> 'Knowledge is for the practioner what the string is for the builder.
> And practice for the learned what the cord is for him who hauls water.
> Without string building will not be exact.

[1253] E. J. Jurji: The Course; op cit; p. 223.
[1254] Mutahhr b. Tahir al-Maqdisi (fl 966) *Livre de la creation* op cit; I: pp. 5-6.
[1255] D.C. Lindberg: *Studies in the History of Medieval Optics* (London, Variorum; 1983).
G. A. Russell: Emergence of Physiological optics, in *Encyclopaedia of the History of Arabic Science* 3 Vols. Edited by R. Rashed (Routledge, London and New York: 1996), pp 672-715.
[1256] See for instance:
L. Sedillot: Memoire sur les instruments astronomique des Arabes, *Memoires de l'Academie Royale des Inscriptions et Belles Lettres de l'Institut de France* 1: 1-229 (Reprinted Frankfurt, 1985).
B. Hetherington: *A Chronicle of Pre-Telescopic Astronomy* (John Wiley and Sons; Chichester; 1996).
R.P. Lorch: The Astronomical Instruments of Jabir Ibn Aflah and the Torquetom; *Centaurus* (1976) vol 20; pp 11-34.
[1257] E.J. Holmyard: *Makers of Chemistry* (Oxford at the Clarendon Press, 1931), p. 60.
[1258] Ibid.

Without cord the thirst will not be slaked.
Who aspires to perfection.
Let him both be learned and practise.'[1259]

An account by an early Islamic astronomer, Habash al-Hasib (9th century), whose *Kitab al-ajram wa al-ab'ad* (Book of Bodies and Distances) is extant,[1260] outlines this spirit of Islamic learning. The passage is as follows:

'The commander of the faithful Al-Mamun desired to know the size of the earth. He inquired into this and found that Ptolemy mentioned in one of his books that the circumference of the earth is so and so many thousands of stades. He asked the commentators about the meaning of stade, and they differed about the meaning of this. Since he was not told what he wanted, he directed Al-Marwarrudhi, Isa al-Astrulabi, and al-Dhari with a group of surveyors and some of the skilled artisans including carpenters and brass-makers, in order to maintain the instruments which they needed. He transported them to a place which he chose in the desert of Sinjar. Al-Marwarrudhi and his party headed for the north pole of *Banat Na'sh* (Ursa Minor), and Isa and al-Dhari and their party headed to the south pole. They proceeded until they found that that the maximum altitude of the sun at noon had increased, and differed from the noon altitude which they had found at the place from which they had separated, by the amount of one degree, after subtracting from it the sun's declination along the path of the outward journey, and there put arrows. Then they returned to the arrows, testing the measurement a second time, and so found that one degree of the earth was 56 miles, of which one mile is 4,000 black cubits. This is the cubit adopted by al-Mamun for the measurement of cloths, surveying of fields, and the distribution of way stations.'[1261]

From this passage are obvious dominant elements of Islamic science (on top of the role of the rulers in the scientific drive): the involvement of teams of scholars in specific scientific tasks; the need to check and clarify

[1259] Az-Zamashhari: *Atwaq ad-dahab*, ed. tr. Barbier de Meynard (Paris, 1876), maqal 77, p. 172.
[1260] Y.Tvzi Langermann: The Book of Bodies and Distances of Habash al-Hasib; *Centaurus*; 28; 1985; pp.108-28.
[1261] In R. Mercier: Geodesy; in *History of Cartography in Prehistoric, Ancient and Medieval Europe, and the Mediterranean;* J.B. Harley and D. Woodward ed (Chicago; 1987), Volume 2; Book 1; Cartography in the Traditional Islamic and South Asian Societies; pp. 175-88; at p.178-9.

extant knowledge; checking experiment, and, obviously, the importance of knowledge derived from such endeavours.

It is best to end this section with these lines for what meaning they carry; lines about the poet Saadi, narrated by Durant. Saadi knew every hardship, and all degrees of poverty; he complained that he had no shoes, until he met a man without feet, 'whereupon I thanked Providence for its bounty to myself.'[1262] In India he exposed the mechanism of a miracle-working idol, and killed the hidden Brahmin who was the god of the machine; in his later rollicking verse he recommended a like summary procedure with all quacks:

'You too, should you chance to discover such a trick,
Make away with the trickster; don't spare him; be quick!
For if you should suffer the scoundrel to live,
Be sure that to you he no quarter will give.
So I finished the rogue, notwithstanding his wails
With stones, for dead men, as you know, tell no tales.'[1263]

5. Islamic Libraries:

According to Yaqut, when Nuh Ben Mansur offered a governorship to al-Sahib b. Abbad (938-995), the latter declined it. He justified his decision on the ground that it would be difficult to transport his books, estimated at 400 camel-loads. Obviously, he much preferred the company of his books to the appointment.[1264] For Al-Hakam II (Caliph in Spain from 961 to 978), books were 'a more consuming passion than his throne.'[1265] In the 10th century we hear of autograph hunters, and book collectors who paid great sums for rare manuscripts.[1266] The book loving mentality of early Islam noted by Erbstosser through an episode in which a Muslim figure, whose ship had

[1262] Saadi: Gullistan, ii; 30 in W. Durant: *The Age of Faith*, op cit, at p.326.
[1263] E.G. Browne: History of Persia; II; p.530 in W. Durant: *The Age of Faith,* op cit, at p. 326.
[1264] Yaqut, ibn-' Abd Allah al-Hamawi, *Irshad al-Arib ila Ma'rifat al-Adib*, also referred to as *Mu'jam al-Udaba*, (Dictionary of Learned Men,) edit., D.S. Margoliouth (Luzac, 1907 ff); vol II, p. 315.
[1265] R. Mackensen: Moslem Libraries and Sectarian propaganda, in *The American Journal of Semitic Languages* (1934-5), pp 83-113 at p. 108.
[1266] S.K. Bukhsh: Studies; 49-50; in W. Durant: *The Age;* op cit; p. 236.

been wrecked and plundered on the coast of the crusader states, complained that:

> 'The well being of my children, the children of my brother and of our wives allowed me to accept the loss of my wealth with ease. What distressed me was the loss of my books. These were four thousand volumes, all precious works. Their loss was the cause of life long sorrow for me.'[1267]

A passion for books in early Islam well expressed by the words of al-Jahiz (776-868):

> 'The book is the companion with whom you do not get bored; it is the friend who does not tire you; it is the colleague who does not deprive you of what you possess through his flattery… If you study the book, it will increase your store of knowledge, sharpen your wit, add to your power of speech, increase your vocabulary, broaden your mind, accord you the respect of people and confidence of kings. Moreover you can learn from books in only a month's time what you cannot learn from people's mouths in ages…. As long as you associate yourself with them (books), you do not need anybody else and you are not forced to prefer loneliness over bad companionship; it relieves you of your worries regarding scarcity of wealth and material prosperity and absence of joy and merriment in your life. In fact, the one who keeps company with books has been bestowed with great privilege and highest favour.'[1268]

A Muslim scholar, of the 8th century, az-Zuhri, possessed a huge collection of books, to which he devoted himself, and so much so, his wife lamented, 'I would prefer three rival co-wives to his love for books.'[1269] Thus, just as it had a passion for gardens, early Islamic society had a passion for books, which contrasts sharply with the generalised contempt for reading amongst most Muslims today, a passion for books in early Islamic society that attracted the interest of many historians of Islam such as Quatremere and Hammer Purgastall;[1270] a passion, whose basic inspiration was the

[1267] M. Erbstosser: *The Crusades;* op cit; p. 136.
[1268] Al-Jahiz: *Kitab al-Hayawan (the Book of Animals)* ed. F. Atawi; vol1; pp. 33-5. in A.L.A. Ibn Dohaish: Growth and Development of Islamic Libraries; in *Der Islam*, vol 66; pp.289-302. at p. 299.
[1269] Ibn Khallikan: *Wafayat al-Ayan;* vol iii; p. 317, in A.L.A. Ibn Dohaish: Growth and Development; p. 292.
[1270] M. Quatremere: Memoires sur le gout des livres chez les Orientaux; in *Journal Asiatique*; VI; (1830); pp. 35-78.
-H. Purgastall: Additions au memoire de M. Quatremere sur le gout des livres chez les Orientaux; *Journal Asiatique*; XI (1848), pp. 178-98.

faith, and which led to two revolutionary changes: the public library, and book production on a large scale.

a. The Islamic Library: Foundation, Rise and Scope:

Islam the faith was, once more, central to the demand for books. Reichmann notes how God created the pen as His great gift to humanity, and all past and future actions of humans are noted in the heavenly books, (as evidenced by the term *maktub,* (it is written).[1271]
There are many quotations from the Qur'an in praise of writing, for instance, 'writing is the tongue of the hand.' The word Qur'an stems from qara'a: to read, or Qur'an 'recitation'.[1272] The writing of Islamic books was a religious commitment, the reading of the Qur'an was a sacred duty demanded from every believer, and to know the entire Qur'an by heart was meritorious and highly rewarded.[1273] This accounts for Islamic civilisation becoming a book culture.[1274] A culture of the book could only result in the institutionalisation of book collection and distribution, hence, the library.

The origin of the Islamic library could go as far back as to the early Umayyad rule (661-750), when Caliph Mu'awiya (661-80) established at Damascus in the early period of his reign a library called *Bayt al-Hikma* (House of Wisdom), housed in a large building, and containing a large collection of books.[1275] His successor, Khalid Ibn Yazid followed suit, and also established a special library that accumulated a large number of books, including his favourite subject, chemistry.[1276] Successive caliphs, whether East or West, did the same at different times in the history of early Islam. Abu Yaqub, the Almohad ruler of Morocco and Muslim Spain (r. 1163-1184), Deverdun says, 'had a great soul and love for collecting books.'[1277] He founded a great library, which was eventually carried to the

[1271] F. Reichmann: *The Sources of Western Literacy* (Greenwood Press; London; 1980), p.205.
[1272] Ibid.
[1273] Ibid.
[1274] A. Grohmann: Arabische Palaeographie; Vienna; Osterreichische Akademie der Wissenschafte; *Denkschriften* 94 (1967-1971) in F. Reichmann: The source; p.205.
[1275] Y. Eche: *Les Bibliotheques Arabes;* Institut Francais de Damas (Damascus; 1967), p. 11.
[1276] A.L.A. Ibn Dohaish: Growth and Development; op cit; p. 295.
[1277] G. Deverdun: *Marrakech*; Editions Techniques Nord Africaines (Rabat; 1959), p.265.

Casbah, and turned into a public library, under the management of erudite Moroccan scholars. Their service, says Ibn Farhun, was one of the privileged state positions, for which only the best scholars were selected.[1278] Some books in the library even constituted part of the Almohad treasury, and were as prized as precious metals.[1279]

Libraries were densely spread throughout medieval Islamic society, from one end of the realm to the other.[1280] Baghdad, for instance, prior to the Mongols, had 36 public libraries[1281] and over a hundred book-dealers, some of whom were also publishers employing a corps of copyists.[1282] The last such libraries in the city was that of the vizier Ibn al-Alkami (who connived with the Mongols, in fact, and was eventually killed by them).[1283] He owned 10,000 books, a library, which perished in 1258 when the Mongols destroyed it alongside the others.[1284] In Marrakech, the Kutubiya Mosque was so named, because around 200 Kutubiya or book sellers had assembled their booths around that Mosque erected by the Almohad ruler Abd al-Mumin.[1285] In the 10th century, Fes, one of the chief seats of Islamic learning, had a library of 300,000 volumes.[1286] Muslim Spain alone had seventy public libraries.[1287] In Merw, around 1216-1218, there were 10 libraries, two in the chief mosque and the remainder in the madrasas,[1288] which were also to perish following the first Mongol invasion of 1219-1221.[1289] The geographer Yaqut (d.1229), who lived through the episode, in fact narrowly escaped the Tartar advance, and fled, wearing no clothes, but clutching his manuscripts, across Persia to Mosul.[1290] He tells us:

> 'I remained there (in Merw) three years… Were it not for what happened after the coming of the Tartars to that land and its devastation… I surely would not have left it till death because of

[1278] Ibid.
[1279] Ibid.
[1280] O. Pinto: 'The Libraries of the Arabs during the time of the Abbasids,' in *Islamic Culture* 3 (1929), pp. 211-43.
[1281] S.K. Padover: Muslim Libraries; in *The Medieval Library*; edited by J.W. Thompson (Hafner Publishing Company; New York; 1957 ed), pp. 347-68; at p. 352.
[1282] A. Von Kremer: *Culturgeschichte des Orients under den Chalifen* (Vienna; 1877), II; p. 483.
[1283] See G. D'Ohsson: *Histoire des Mongols*; op cit; vol 3.
[1284] S.K. Padover: Muslim Libraries; op cit; pp. 351-2.
[1285] R. Landau: *Morocco;* op cit; p.80.
[1286] F. Reichmann: *The Sources of Western Literacy;* op cit; p.208.
[1287] G. Le Bon: *La Civilisation*; op cit; p. 343.
[1288] Yaqut: Mu'jam in J. Pedersen: *The Arabic Book*, p. 128.
[1289] See final part under appropriate heading for the fate of Muslim libraries.
[1290] W. Durant: *The Age of Faith*; op cit; p. 329.

> the people's generosity, kindness, and sociability, and the multitude of sound fundamental books there. For when I left it there were in it ten endowed libraries, the like of which, in numbers of books, I had never seen. Among them were two libraries in the mosque, one of them with 12,000 volumes… and there is the library of Sharaf al-Mulk, the accountant; and the library of Nizam al-Mulk in his mosque; and two libraries (belonging to the Samani faculty), and another library in the Amiduia College. And a library belonging to Majd al-Mulk, one of the later viziers there; and the Khatuniya (princess) libraries in the mosque-college; and the Damiruja.'[1291]

And so it was through the land of Islam; so widespread were public book collections, that it was impossible to find a mosque or a learning institution of any sort without a collection of books placed at the disposal of students or readers.[1292] And the medieval Islamic public library, Eche states, did not just serve the parent institution in the accomplishment of its scientific purpose, which it reflected scrupulously, as a place for permanent storage; it perpetuated the best scientific works, kept the most precious documents, and even scientific instruments.[1293]

One of the most famed libraries of Islam was that of Tripoli (northern Lebanon, today).[1294] Tripoli was a natural port in what was then Syria, and was very prosperous thanks to its farm products and its manufacture. When the first crusaders sacked it in 1109, it had a population of 20,000 chiefly engaged in the making of glass and paper; it possessed a splendid mosque, rich bazaars, and houses from four to six storeys high.[1295] According to Michaud, it had four thousand workmen involved in textile manufacturing,[1296] and also had a large paper workshop, which helped spread the making of books.[1297] Already, at the time of Al-Ma'ari, cited above, the city had many public libraries organised under waqf endowments.[1298] The largest library in the city was founded some time in

[1291] Yaqut, Ibn Abd Allah al-Hamawi: *Jacut's Geographisches Worterbuch,* ed. F. Wustenfeld. 6 vols (Leipzig, 1866-70), vol iv; p. 509; I. 9. in S.K. Padover: Muslim Libraries; op cit; p. 355.
[1292] A. Shalaby: *History of Muslim Education* (Dar Al Kashaf; Beirut; 1954), p 95.
[1293] Y. Eche: Les Bibliotheques; op cit; p. 299.
[1294] M. Quatremere: Memoires sur le gout des livres chez les Orientaux; op cit.
[1295] R. Rohricht: *Geschichte des konigreichs Jerusalem* (Innsbruck; 1898), p. 78.
[1296] M. Michaud: *Histoire des Croisades* (Paris; 1825), II; p. 54.
[1297] Kurd Ali: *Khitat al-Sham;* Damascus; 6 vols (Al-Matbaa al Haditha, 1925-8), VI; p. 191.
[1298] Al-Dahabi: *Tarikh al-Islam*; Aya Sofya; 4009; vol XI; year 499 H.

the 11th century.[1299] It was one of the richest and best endowed the Muslims ever had, and according to Ibn Abi Tay, it included 3 million works (which is much higher than the figure given by Al-Nuwayri) and it employed 180 copyists, who were remunerated for day and night work.[1300] The city's ruling dynasty, the Banu Ammar gave all their attention and support to this library, and they sent their agents to all places to acquire works to place in their library.[1301] Under their rule, Tripoli became the centre of attraction for scholars, who worked in their service.[1302] This library also sheltered an active scholarly life involving students and scholars, but this life was cut short following the crusades.[1303] In 1109, the crusaders besieged the city, and it surrendered to them. The outcome was looting and devastation, and the thorough destruction of its great library by flames, and the great loss of many scientific works of immense value.[1304]

Rulers and leading figures played a crucial part in the life of the libraries. The university of Al-Mustansiriya of Baghdad had a rich library composed largely of books transferred from the very private library of the Caliph.[1305] In Damascus, Nur Eddin Zangi gave large collections of books to the many libraries of the city,[1306] whilst in Cairo, al Qadi al-Fadil presented his schools with 100,000 volumes on various subjects for the use of students.[1307] In Spain, Al-Hakam II's (r.961-976) collection was estimated at 400,000 to 600,000 books.[1308] The list of catalogues recording only the names of the authors and the titles of the books consisted of 44 volumes.[1309] He engaged copyists and bookbinders, and had agents sent to every province to procure books for him by purchase and by transcription.[1310] In Western Christendom, four hundred years later, Charles the Wise could gather in his royal library of France, nine hundred volumes, of which only a third were not dealing with theology.[1311] The Reyes of Tayfas, princes who

[1299] Y. Eche: *Les Bibliotheques Arabes;* op cit; p. 118.
[1300] Al-Nuwayri BN, ar. 1578; 116 r. in Y. Eche: *Les Bibliotheques Arabes;* op cit; p. 118.
[1301] Y. Eche: *Les Bibliotheques Arabes;* op cit; p. 118.
[1302] Ibn Al-Furat: *Tarikh al-Duwal wa'l Muluk*; Ms National Library of Vienna; A.F. 117; I; p. 38.
[1303] Y. Eche: *Les Bibliotheques Arabes;* op cit; p. 119.
[1304] Sibt al-Jawzi in *Recueil des Historiens Orientaux des Croisades* (Paris; 1884), III; 536.
[1305] Ibid; p.102.
[1306] Ibid.
[1307] Al-Makrizi: *al-Khitat*, op cit, II, p. 366.
[1308] J. Pedersen: *The Arabic Book*, op cit, p. 120.
[1309] Al-Maqqari: *Nafh al-Tib*, op cit II, p 180.
[1310] J. Pedersen: *The Arabic Book*; op cit; p.120:
[1311] G Le Bon: *La Civilisation;* op cit; p. 343.

succeeded the Umayyad in Spain (early 11th century), also became celebrated for their libraries at Saragossa, Granada, Toledo, and elsewhere.[1312] Back in the East, Adud al-Daula (d.983), founded a library in Shiraz, which, in the words of al-Muqaddasi was:

> 'A complex of buildings surrounded by gardens with lakes and waterways. The buildings were topped with domes, and comprised an upper and a lower story with a total, according to the chief official, of 360 rooms.... The library, which contained much scientific literature was in the charge of a director, a librarian and a superintendent. The books were stored in a long arched hall, with stack rooms on all sides. Against the walls stood book-presses, six feet high and three yards wide, made of carved wood, with doors which closed from the top down, each branch of knowledge having separate book cases and catalogues. In each department, catalogues were placed on a shelf... the rooms were furnished with carpets...'[1313]

A considerable number of private libraries thrived, too, especially amongst scholars. Amongst the scholars of Islam, there was none who could be found without a collection of books of his own, Shalaby, thus, concluding, that the number of these libraries equalled the number of learned people.[1314] This collection was an indispensable tool for the scholar, and it included, in general, all the works that his never interrupted studies allowed him to buy or copy.[1315] There are countless instances of such libraries. Al-Waqidi, at his death, in the year 823, left 600 boxes of books, each so heavy that two men were needed to carry it[1316] Al-Baiqani (1033) had so many books that it required sixty three hampers and two trunks to transport them, whilst a 10th century scholar, Mohammed ben al-Husain of Haditha had a collection of rare manuscripts that was so precious that it was kept under lock and key.[1317] The library of the physician Ibn al-Mutran, had, according to Ibn Abi Usaybi'a more than 3000 volumes; and three copyists worked constantly in his service.[1318] And we hear of a private library in Baghdad, in the 9th century, which required 120 camels to move it from one place to

[1312] J. Pedersen: *The Arabic Book*; op cit; p 121.
[1313] AL-Muqqadasi: *Ahsan al-Taqasim;* edited by de Goeje, op cit; p. 449; Von Kremer: *Culturgeschichte des Orients under den Chalifen*; op cit; II; pp. 483-4.
[1314] A. Shalaby: *History*, op cit, p. 107.
[1315] Y. Eche: *Les Bibliotheques;* op cit; p. 282.
[1316] E.G. Browne: *Literary History of Persia* (1908), I; p. 275.
[1317] S.K. Padover: Muslim Libraries; op cit; pp. 351-2.
[1318] In F. Micheau: The Scientific Institutions in the Medieval Near East, in *The Encyclopaedia of the History of Arabic Science*, Ed by R. Rashed (Routledge; London; 1996), pp 985-1007, at p. 988:

another.[1319] Under Almohad rule, in Morocco, there was the famed 13th century Maktaba (Library) of Ibn Tarawa, who was a great lover of chroniclers, besides being a manuscript writer.[1320] Also famed were the Maktaba of al-Qaysi and the Maqtaba of Ibn as-Suqr, the main librarian of the imperial library, his collection requiring five full camel loads to be carried.[1321] Eche notes how the richness of any scholar's library was valued according to its scientific content, a collection, which nearly always ended in public libraries, thus enriching them considerably.[1322]

Private libraries were numberless amongst other groups, for it was a fashion among the rich to have an ample collection of books.[1323] Among such libraries, the library of Abu al-Mutrif (d. 1001), a Cordovan judge, was sold at auction in the mosque for a whole year, bringing in 40,000 dinars.[1324] Al-Maqqari quotes this passage from Ibn Said who held:

> 'To such an extent did this rage for collection increase that a man in power or holding a situation in the government considered himself obliged to have a library of his own and would spare no trouble or expense in collecting books merely in order that people might say 'such a one has a very fine library.'[1325]

Muslim scholars' bequests of books, and the establishment of waqfs for the purpose, served to enrich the libraries considerably. Al-Khatib al-Baghdadi (d. 1070) constituted into a waqf all his works and writings for the benefit of Muslims. Some such works are known to us.[1326] The Faqih al-Humaydi (d. 1095), also known as man of letters, loved books so much that he worked at night copying them. He also constituted his collection into a waqf for the benefit of those engaged in scientific work.[1327] This must have been a rich collection, for he copied much and gathered plenty of notes. Al-Mustazhari (d. 1115), a very pious and generous figure, also constituted as a waqf for the learners of Tradition, a good number of books, which included the *masnad*

[1319] F.B. Artz: *The Mind*; op cit; p.153.
[1320] G. Deverdun: *Marrakech*; op cit; p. 265.
[1321] Ibid.
[1322] Y. Eche: *Les Bibliotheques*; op cit; p. 282.
[1323] W. Durant: *The Age of Faith*; op cit; p. 236.
[1324] W. Gottschalk: Die Bibliotheken der Araber im Zeitalter der Abassiden; *Zentralblatt fur Bibliothekswesen*; XLVII (1930); pp. 1-6.
[1325] P. De Gayangos: *The History of the Mohammedan Dynasties in Spain* (extracted from *Nifh Al-Tib* by al-Maqqari); 2 vols (The Oriental Translation Fund; London, 1840-3), Vol 1; pp. 139-40.
[1326] Y. Eche: *Al-Habib al-Baghdadi* (Damascus; 1364), pp. 92-137.
[1327] Al-Dahabi: *Tadkirat al-Hufaz*; Hydarabad; ND; IV; p. 20; Al-Maqqari: *Nafh al-Tibb*; I; p. 382.

of Ibn Hanbal.[1328] Al-Katib (d. 1218), the last representative of the family of writers of Banu Hamdan, constituted as a waqf for the benefit of students a good part of his collection, made up of many original works.[1329] Ibn Harit (d. 1322), a Faqih, a reader and lexicographer constituted his book collection as well as his properties into a waqf.[1330] The chief of physicians, Al-Muhaddab Ibn Ali al-Dawhar (d. 1230) made of his house south of the Umayyad Mosque in Damascus a madrasa devoted to medicine. He had himself copied a large number of works in his meticulous hand-writing, and these books, estimated at over a hundred volumes on medicine and other sciences, were constituted into a waqf for the madrasa for the use of Physicians.[1331]

One of the most notable traditions long held by the Muslims was to bequeath their manuscripts and book collections, sometimes thousands of volumes, to mosques.[1332] As Pedersen notes, because mosques were not just devoted to worship, but were also seats of learning, it was normal that people should give their libraries to mosques, and an entire book collection might be transferred to a mosque as a self contained library or *dar al-kutub*.[1333] Al-Jaburi reported that Naila Khatun, a wealthy widow of Turkish origin, founded a mosque in memory of her deceased husband, Murad Afandi. She attached to the mosque a madrasa and a library for which she reportedly bought many valuable books and manuscripts.[1334] In Iraq, the Abu Hanifa mosque had an impressive library, which benefited from the gifts of private collections, amongst which was one by the physician, Ibn Jazla (d 493H/1099) and the writer historian al-Zamakhshari (d 538H/1143).[1335] In Aleppo, the largest and probably the oldest mosque library, the Sufiya, located at the city's Grand Umayyad Mosque, contained a large book collection of which 10 000 volumes were reportedly bequeathed by the city's most famous ruler, Prince Sayf al-Dawla.[1336] The famed historian, Abu'l

[1328] Muntazam; ed. Haydarabad; IX; p. 183. in Y. Eche: *Les Bibliotheques*; op cit; p. 196.
[1329] Al-Dubayti: *Dayl Tarikh al-Salam;* Mss at the Bibliotheque Nationale (Paris); ar. 2133; 173 v.
[1330] Al-Safadi: *Al-Wafi bi'l wafayat;* Ms of Ahmad III; Istanbul; No 2920; ed. Ritter; I; p. 232.
[1331] Sibt al-Jawzi: *Mir'at al-Zaman;* Ms of Bibliothque Nationale; ar. 1505; 1506; 5866; ed by J. Richard (Chicago; 1907) and Ms Fayd Allah 1524; IX; 88 v.;. in Y. Eche: *Les Bibliotheques*; op cit; p. 236.
[1332] R. Mackensen: Background of the History of Muslim libraries.' *The American Journal of Semitic Languages and Literatures,* vol 51; Four Great Libraries....', op cit.
[1333] J. Pedersen: *The Arabic Book*, op cit, p. 126.
[1334] Al-Jaburi, Maktabat al-Awqaf... op cit. p, 89, in M. Sibai: *Mosque Libraries*, op cit, p 92.
[1335] M. Sibai: *Mosque Libraries*, op cit, p 81.
[1336] Ibid; p 71.

Fida, built in the city of Hama a beautiful mosque and constituted into a waqf a collection of books, numbering seven thousand volumes, of all sorts of sciences, a collection, which it is said, was without equal.[1337] It included works he had collected with considerable effort from various parts of the East and the West.[1338] Yaqut, the famed geographer, also left his collection as waqf to the Zaidi mosque library.[1339] In Al-Qayrawan, the manuscripts were endowed to students by those who sought Allah's favour and pleasure, as was recorded on many such manuscripts.[1340] In the year 1548, the Qarawiyyin teacher, Abu Abd Allah Muhammad al-Ajmawi, bequeathed his large work, *al-Qawl al-Mutabar* to the students of the mosque,[1341] which came after Ibn Khaldun had bequeathed to the same Mosque library his *Kitab al-Ibar*, to be lent only to trustworthy men for the period of two months.[1342] Most often, this gesture is a mark of gratitude by the scholar towards the mosque for their upkeep and support.[1343]

b. Muslim Libraries: Their Public Role and their Management:

Mackensen notes that the contrast between the Christian West and medieval Islam was not just in terms of size of book collections, but also extended to the fact that whilst Western Christendom restricted access to books, Islam encouraged it.[1344] The Islamic attitude, again, derives from the Prophet's summons:

> 'The first blessing that accrues to a person occupied with the transmission of traditions consists of the fact that he has the opportunity to lend books to others.'[1345]

This summons permeated all echelons of Islamic scholarship and society; the scholar abided by it, and elaborated on it. Ibn Jammah's advised his students in his *Books as the Tools of the Scholars*, written in 1273:

[1337] M. Kurd Ali: *Khitat al-Sham*. 6 Vols, (Damascus: Al-Matbaa al Haditha, 1925-8), IV; p. 193. Y. Eche: *Les Bibliotheques*; op cit; p. 248.
[1338] Ibn Higga: *Tamarat al-awraq* (Cairo; 1339), I; p. 75.
[1339] Ibn al-Imad: *Shaderat al-dahab*, v: 122, in A. Shalaby: *History*, op cit, p. 101.
[1340] M al-Rammah: The Ancient Library of Kairaouan and its methods of conservation, in *The Conservation and preservation of Islamic manuscripts*, Proceedings of the Third Conference of Al-Furqan Islamic Heritage Foundation (1995), pp 29-47, p. 32.
[1341] A al-Fasi: *'Khizanat al Qarawiyyin wa nawadiruha,'* Majallat Mahad al-Makhtutat al-Arabiya 5 (May 1959): 3-16. p. 9.
[1342] W. Heffening: Maktaba; in *Encyclopaedia of Islam*, op cit; vol VI, p. 199.
[1343] M. Sibai: *Mosque Libraries*, op cit, p 90.
[1344] R. Mackensen: Moslem Libraries; op cit; p. 109.
[1345] In M. Sibai: *Mosque Libraries*, op cit; p. 105.

> 'Books are needed in all useful scholarly pursuits. A student, therefore, must in every possible manner try to get hold of them. He must try to buy, or hire, or borrow them, since these are the ways to get hold of them. However, the acquisition, collection, and possession of books in great numbers should not become the student's only claim to scholarship.... Do not bother with copying books that you can buy. It is more important to spend your time studying books than copying them. And do not be content with borrowing books that you can buy or hire.... The lending of books to others is commendable, if no harm to either borrower or lender is involved. Some people disapprove of borrowing books, but the other attitude is the more correct and preferable one, since lending something to someone else is in itself a meritorious action and, in the case of books, in addition serves to promote knowledge.'[1346]

Many libraries were founded for the sole purpose of lending books.[1347] We even find in the waqf stipulations the basic rule for book lending. Thus, in *luga* 42 of the Zahiriya Library, the following rule stipulated by the waqf said:

> 'Gifted for the profit of all Muslims and deposited at the madrasa al-Gawziyya of Damascus. Those who require such works can use them and then after use must return them back to the madrasa.'[1348]

In Islam, in fact, caliphs, viziers, and scholars, were extremely generous in supporting access to, and use of libraries, including their own. In the Grand Palace of Ali b. Yahya al-Munajjim (897) in Iraq, there was a great library with the name *Khizanat al-Hikmah* visited by people who travelled from different places to study. Accommodation was available for those amongst them who sought to live in the library wing, and food too was made available.[1349] In the 900s, a *Dar al-Ilm* (House of Learning) was established in Mosul, northern Iraq, by Mohammed Ibn Hamdan al-Mawsili (854-934).[1350] Ibn Hamdan was in the habit of visiting this library every day.[1351] It included books in all sorts of sciences, especially philosophy and astronomy,[1352] and was open to all seekers of learning who were supplied

[1346] In F. Rosenthal: *Technique and Approach of Muslim Scholarship* (Rome; Pontificum Institutum Biblicum; 1947), pp. 8-9.
[1347] Y. Eche: *Les Bibliotheques Arabes;* op cit; p. 384.
[1348] Ibid.
[1349] Yaqut: *Muujam al-Udaba*, op cit; V, p. 467.
[1350] O. Pinto: Le Biblioteche degli Arabi nell eta degli Abbasidi; in *Bibliofilia di L. Olschki;* vol XXX; p.151.
[1351] Y. Eche: *Les Bibliotheques Arabes;* op cit; p. 99.
[1352] R.S. Mackensen: Background; op cit.

with paper as well as books.[1353] The geographer Yaqut al-Hamawi (d. 1229) adds that the library was bequeathed in favour of all seekers of knowledge, and no one was denied access to it: even if a stranger wished to enter it he was allowed to do so.'[1354] Admission was not just granted to everyone, but poor students could be financially supported, too.[1355] The scholar Ibn Abbad (938-995) had a library, whose book list filled ten catalogues.[1356] He was interested in philosophy, science and techniques, and was very generous with scholars; he gave each, it was said from 100 to 500 dirhems and a garment.[1357] At Basrah (Basra), Abu 'Ali b. Sawwar, a learned man and a patron of learning, founded two libraries, where students could read and copy books, and could also be fed.[1358] Ibn Hibban (d. 965), the qadi (judge) of Nishapur, bequeathed to the city a house with a library and quarters for foreign students and provided stipends for their maintenance.[1359] In Ispahan, a rich landowner established a library in 855, and is said to have spent 300,000 dirhems on books.[1360] In Morocco, the Merinid sultan Abu Inan, avid reader and book collector, founded at the Qarawiyyin of Fes the Abu Inan Library, in which he deposited books on various subjects for the readers, who found not only room for consultation of such books but also items such as paper, pens etc.[1361]

The organisation and management of Muslim libraries was quite remarkable, and descriptions of both public and private libraries speak of the classification of books and their arrangement in separate cases or even in separate rooms in the Baghdad libraries.[1362] 'Great care,' says Olga Pinto, 'was taken concerning the buildings which were to serve as public libraries. Some of them, like those of Shiraz, Cordova and Cairo, were placed in separate structures, with many rooms for different uses: galleries with shelves in which the books were kept, rooms where the visitors could read and study, rooms set apart for those in charge of making copies of manuscripts, rooms which served for literary assemblies etc.'[1363]

[1353] W. Durant: *The Age of Faith*; op cit; p. 237.
[1354] Yaqut al-Hamawi quoted in A.L.A. Ibn Dohaish: Growth and Development; op cit; p. 297.
[1355] Yaqut: Mu'jam; op cit; II, p. 420.
[1356] S.K. Padover: Muslim Libraries; op cit; p. 353.
[1357] A. Mez: *Die Renaissance des Islams* (Heidelberg; 1922), p. 95.
[1358] A Shalaby: *History;* op cit; p. 98.
[1359] S. Khuda Bukhsh: The Renaissance of Islam; *Islamic Culture*; IV (1930), p. 297.
[1360] Ibid; p. 295.
[1361] M. Sibai: *Mosque Libraries*, op cit; p 55.
[1362] F.B. Artz: *The Mind*; op cit; pp.152-3.
[1363] O. Pinto: The Libraries; op cit; p. 227.

There was accurate cataloguing of all contents to help readers, whether the library was private or public. One single private collection required 10 volumes,[1364] whilst in Spain, the catalogue for the works in al Hakkam's library is alleged to have consisted of 44 volumes.[1365] The contents of each section of a bookshelf were also registered on a strip of paper attached to the shelf outside; which bore indications of works which were incomplete or lacking in some part.[1366] Book lending, too, followed strict regulations, such as that readers were urged to take great care of borrowed books, not to write comments or correct any mistakes found in the book, but instead to report them to the librarian; and return the borrowed items by a given date.[1367]

It was the practice to appoint a librarian to take charge of the affairs of the library,[1368] but such duty was only for the most learned amongst Muslims; only men 'of unusual attainment' were allowed the privilege to be custodians of the libraries.[1369] The Sufiya of the Grand Mosque of Aleppo library, for instance, had in charge of it Muhammad al-Qasarani, an accomplished poet and a man well versed in literature, geometry, arithmetic and astronomy.[1370] The Nizamiya library of Baghdad had as one of its earlier custodians Abu Yusuf Ibn Dawud, who was a faqih, a methodologist, a man of letters, calligrapher and poet.[1371] Another of its custodians was Abu Zakaria al-Tabrizi, a man of letters, author of many masterpieces, who was also appointed as teacher of literature and philosophy in the Nizamiya madrasa itself.[1372] In Spain, in the provinces, the custody of the assembled manuscripts was entrusted to a noble of distinction; but at the capital the charge of the magnificent library of A1-Hakem was considered an employment worthy of royalty itself, and was committed to Abd-al-Aziz, a brother of the caliph.[1373] Such men, Mackensen notes, were themselves pleased to act as librarians. 'It speaks highly for the generosity of the patrons as well as for the really important work carried out in these libraries that men

[1364] F.B. Artz: *The Mind;* op cit; p.153.
[1365] Al Maqqari: *Nafh al-Tib*, op cit; I, p. 186.
[1366] O. Pinto: The Libraries; op cit; p. 229.
[1367] A. Shalaby: History; op cit, Pp 82-3.
[1368] E.L. Provencal: *Nukhab Tarikhiya Jamia li Akhbar al-Maghrib al-Aqsa* (Paris: La Rose, 1948), pp 67-68.
[1369] R.S. Mackensen: Background, op cit; p. 24.
[1370] Y. Eche: *Les Bibliotheques Arabes,* op cit p. 134.
[1371] Asnawi: *Tabakat al-Safi'ya;* ms of the Zahiriya; Tarikh; 56; 18 v. and 19 r.; Al-Subki: *Tabaqat al-Safi'ya* (Cairo; 1323), IV; p. 29.
[1372] Yaqut: *Irsad al-Arib*; ed. Margoliouth; vol vii; p.286.
[1373] S.P. Scott: *History;* op cit; vol 3; p.465.

of marked ability in various fields felt it worth their while to undertake the duties of custodian.'[1374]

Equally intensely sought after were copyists and it was the generalised rule in Muslim libraries to employ many of them together with calligraphists, and to employ the most illustrious of them.[1375] Caliph al-Hakam II of Spain gathered around him men with great skills in the art of copying,[1376] including the famed Zifr al-Baghdadi, whom he had brought specially from Baghdad.[1377] The Abbasid Caliph Al-Musta'sim did the same in the search of copyists for his library at the Mustansiriya.[1378] Abu al-Mutrif (d.1001), a Cordovan judge, possessed a magnificent library, largely of rare books and masterpieces of calligraphy.[1379] He employed six copyists, who were constantly at work, and bought books in large quantities.[1380] The judge never lent a manuscript, but had copies made as gifts.[1381]
Generally, Watts explains, a master would slowly read out a scholarly work and scribes would copy down what he said.[1382] Depending on how many scribes he employed, ten or fifteen or more copies of a 300 page book could be produced in a few weeks.[1383] It was in this way that, by 1236, when it was burnt by the crusading Christians, the great Library in Islamic Cordoba, had built up a collection said to number 400,000 books.[1384] To conform to the original, the work of the copyist, however meticulous he was, necessitated not just skills in writing, but also exactitude, and once the text was copied, other scholars checked it.[1385] Often, a famed scholar took on this task, and corrected copies; al-Farisi (d. 983), for instance, was employed two days a week in the correction of the *Tadhkira of Sahih* Ibn Abbad, which was copied for the library of *Kafi al-Kifaya.*[1386] The search for exactitude also prompted the search for the copyist who knew best the work to be copied, or the person owning the best of the manuscripts.[1387]

[1374] R.S. Mackensen: Background; op cit; p. 24.
[1375] Y. Eche: *Les Bibliotheques;* op cit; p. 273.
[1376] Ibn Khaldun: *Al-Ibar wa diwan al-mubtada wa'l-habar*; ed Bullaq (1284 (H); IV; p. 146.
[1377] Ibn al-Abbar: *Kitab al-Takmila* (Madrid; 1886), Vol I; p. 86.
[1378] Al-Safadi: *Al-Wafi bi'l wafayat;* Ms of Ahmad III; Istanbul; No 2920; XIX; p. 118 v;..
[1379] S.K. Padover: Muslim libraries; op cit; p. 362.
[1380] Ibid.
[1381] Ibid.
[1382] S. Watts: *Disease and Medicine in World History* (Routledge; 2003), p.40.
[1383] Ibid.
[1384] S. Watts: *Disease and Medicine*; op cit; p.40.
[1385] Y. Eche: *Les Bibliotheques;* op cit; p. 274.
[1386] Ibid; p. 275.
[1387] Ibid.

From the point of view of their role in Muslim society and their place in human civilisation, their organisation and functions, their size and impact, and their innovative character, Islamic public libraries, Eche concludes, did not just surpass by far any similar institution that might have existed elsewhere, but they were only surpassed by modern libraries by around the 17th century after mass printing made possible the distribution of books on a grand scale.[1388] Most certainly, Islamic private libraries could be ranked on the same level of importance.

c. The Rise of the Book Industry:

The early Muslim passion for books did not just lead to the rise of one of the greatest institutions of human civilisation, it also led to the advent and advancement of some essential functions, crafts and trades, which had dramatic effects on the worlds of intellect and industry.

Muslims were great book collectors, and this stimulated a flourishing book trade.[1389] At its foundation was the *Warraq* profession (waraq being the Arabic word for paper), which developed considerably.[1390] The *Warraqeen* (plural Warraq) traded mostly in paper, but also copied rare manuscripts they managed to obtain from often distant places, and made them available to the public at reasonable prices.[1391] The manuscripts that the warraqs transcribed during public dictations had little value unless they carried the *ijaza* (licence), they were copies authorized by their authors.[1392] The function of getting the *ijaza* and distributing the approved manuscripts was performed by the warraqs, a process, which was long and complicated, but which ensured that the rights of the author were preserved and plagiarism was kept at bay.[1393] Once the warraq made a copy of the author's work, it was read back to him three or more times in public; each time, the author making amendments or additions which required further readings.[1394] Only when the author was finally satisfied, did he place the ijaza on the copies that he approved; the ijaza signifying

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[1388] Ibid; pp. 396-7.
[1389] F.B. Artz: *The Mind;* op cit; p.152.
[1390] M. Sibai: *Mosque Libraries*, op cit, p. 41.
[1391] Ibid.
[1392] Z. Sardar-M.W. Davies: *Distorted Imagination*; op cit; p. 99.
[1393] Ibid.
[1394] Ibid.

that he granted permission 'to transmit the work from him' in the form as approved. If the author of a particular work was dead, then the copy was read out by a distinguished scholar, who charged an honorarium for his service and gave his ijaza to the manuscript.[1395] The ijaza did not give the warraq copyright over the work; it was simply an assurance that he passed the book in the form determined by the author and was empowered to transmit the book in the same form to others.[1396]

Baghdad, most probably, was the first place where the Warraqeen bookshops appeared,[1397] Yaqubi (d.897) says that in his time Baghdad had over a hundred booksellers.[1398] The bookshops were often situated around the town's principal mosque; scholars and men of letters used them as places where they could gather.[1399] It was in these shops that al-Jahiz would pay for the privilege of being locked in all night in order to read a copy that he wanted.[1400] From Iraq, bookshops spread westward. In the bazaars of Cordova, which possessed the largest book market in Spain, manuscripts were bought and sold like any other commodity.[1401] In Cairo, according to Ibn Zulaq, under Tulunid and Ikhlisid rule (9th century), there was a special bazaar for the *Warraqeen* where books were sold and debate took place.[1402] The intellectual role of such places in Egyptian life was subsequently studied by al-Makrizi (d.1442).[1403] Such an intellectual role was not strange to Muslim Spain, where Zainab and Hamda, the daughters of Zaid, the bookseller who lived at wadi al-Hima in the neighbourhood of Grenada, were 'excellent poetesses, thoroughly versed in all branches of learning and science.'[1404]

The profession of warraq also stimulated a diversity of trades, here well outlined by Durant. The Warraqs, he said:

> 'Made ever lovelier Kurans for Seljuk, Ayyubid, or Mamluk mosques, monasteries, dignitaries, and schools, and engraved upon the leather or lacquer bindings designs as delicate as a spider's web. Rich men spent small fortunes in engaging artists to

[1395] Ibid.
[1396] Ibid.
[1397] W. Durant: *The Age of Faith*; op cit; p.319.
[1398] Ibid; p. 236.
[1399] G. Wiet et al: *History*; op cit; p.448:
[1400] Yaqut: *Mu'jam al-Udaba*; op cit; Vol VI, p. 56.
[1401] S.K. Padover: Muslim Libraries; op cit; p. 361.
[1402] Ibn Zulaq, *Akhbar Sibawiy al-Misri*, pp. 33, 44 MS 1461; Tarikh Taimur, Egypt; in A. Shalaby: *History*, op cit, p. 27.
[1403] Al-Makrizi: *al-Khitat*, vol I, p. 361, Vol II p. 96.
[1404] Sayid Amir 'Ali: in A. Shalaby: *History*, op cit, p. 28.

> make the most beautiful books ever known. A corps of papermakers, calligraphers, painters, and bookbinders in some cases worked for seventeen years on one volume. Paper had to be of the best; brushes were put together, we are told, from the white neck hair of kittens not more than two years old; blue ink was sometimes made from powdered lapis lazuli, and could be worth its weight in gold; and liquid gold was not thought too precious for some lines or letters of design or text.'[1405]

Paper, a Chinese invention, was turned by the Muslims into an industry that led to the massive production of books. The literary necessities of a highly educated population, the multiplication of manuscripts, the requirements of innumerable institutions of learning, and the need to stack the shelves of libraries, in turn stimulated the industry.[1406] The use of paper rather than papyrus or parchment, in turn, made books relatively cheap.[1407] Thus, whilst elsewhere books were 'published' only through the tedious labour of copyists, in the Muslim world hundreds, even thousands of copies of reference materials were made available to those wishing to learn.[1408] All this had decisive impacts subsequently, when transmitted to the West. The Europeans of the Middle Ages wrote only on parchment but its high price was a serious obstacle to the multiplication of written works.[1409] By making use of this new material, paper, and manufacturing it on a large scale, in the words of Pedersen, the Muslims 'accomplished a feat of crucial significance not only to the history of the Islamic book but also to the whole world of books.'[1410]

[1405] W. Durant: *The Age of Faith;* op cit; p.319:
[1406] S.P. Scott: *History;* op cit; vol 2; p. 387. J. Pedersen: *The Arabic Book*; op cit; pp. 50 sq.
[1407] F.B. Artz: *The Mind;* op cit; p.152.
[1408] M. Nakosteen: *History*, op cit, p. 37.
[1409] G Le Bon: *La Civilisation*; op cit; p. 391.
[1410] J. Pedersen: *The Arabic Book*, op cit, p. 59.

Concluding Words to Part One

This part has endeavoured to give a general picture of Islamic civilisation. It has revealed how Islamic civilisation touched most aspects of learning and culture, on a much wider scale than any other. Indeed, this is a crucial point, which hardly any historian has made, that no other civilisation, except the Islamic, has affected such diverse areas as trade, industry, architecture and design, water supply and gardening, universal learning and book manufacturing as well as the sciences. No other civilisation has also brought such diverse sections of the community, as well as other communities, into such an effort. It is a unique experience with which even modern societies today fail to compare.

This first part has also shown, in many ways, how Islamic civilisation, in its fundamental manifestations, whether with regard to trade, banking, scholarship, garden design, or the universality of learning, or other aspects looked at, was fundamentally inspired by the faith, Islam.

This part has also already touched upon the fundamental problem dealt with by this work: the fallacies of Western historian and their derogatory approach to all matters Islamic.

The following parts will deepen the focus on the latter issue in particular. And if the first part has stayed with the general, and generalised, the following two parts will linger on the detail, and dwell on every argument as much as is deemed necessary.

PART TWO

MUSLIM SCIENCES AND SCIENTISTS

Expressing a view common amongst mainstream modern Western historians, an otherwise reliable figure, Dawson, says:

> 'No doubt Arabic scientists were the heirs of the Greek tradition and were not unworthy of their inheritance. But while they preserved it, they unconsciously transformed it by infusing a different spirit into it. In spite of its achievements Arabic science belongs to the same world as the Arabian Nights-a world of magic and mystery-and the scientist was the man who could control these mysterious forces by the power of secret knowledge. What he sought was not knowledge, but power: To discover the Elixir of Life, the Philosopher's Stone, the Talisman, the Word of Power, and the magic properties of plants and minerals. His astronomy was inseparable from astrology, and his chemistry from alchemy. In a word, Arabic science was magic.'[1411]

Likewise, M.C. Lyons holds:

> '(Muslim) chemistry seems merely a step towards alchemy, whose adepts graduate from transmuting base metal into silver to transmuting silver into gold. Even then they fell short of the miracle workers who could make gold coins appear from empty air. Similarly astronomers might produce accurate and useful tables, but the only way in which they could achieve patronage was by turning to astrology and court astrologers are shown as having the same kind of position and influence as court doctors. Even mathematics seems treated as a pathway to magic and the figures of Archimedes are explained as having supernatural significance. Technology, though it never achieved the same

[1411] C. Dawson: *Medieval Essays* (Sheed and Ward: London; 1953), p.159.

> magical connotations, nevertheless seems to have suffered something of the same fate, in that its refinements were devoted to toys or tricks.'[1412]

Equating Islamic science with magic and folklore is no lone approach aimed at lowering its status on the part of Western historians. Here follows a small sample of others. First, the claim that Muslim science brought little or nothing that was new to learning. Sherwood Taylor informs us:

> 'The new discoveries of the Arabic world were few: the Arabs must be looked on as preservers of knowledge rather than originators of it. They absorbed foreign ideas with astonishing readiness and their assimilation of Greek culture was a fine achievement; none the less they originated no single great conception. The Moslem theology regarded all events as direct acts of God, a view which denied scientific law and made the miraculous credible. The scientific world-view was, therefore, somewhat foreign to the Moslem genius and, as might be expected, a great number of the men of science who flourished under the Arabs were not of Arab blood, but were Syrians, Persians or Jews.'[1413]

And again:

> 'The Arabs gave high place to their physicians, who were usually of another race, Persian, Jew or Syrian Christian. They made very few original contributions to medicine but kept alive the knowledge of the Greeks and added little to it.....'[1414]

A point emphasised by Garrison:

> 'Apart from mathematics and polite literature, the Moslems were assimilators and transmitters rather than innovators. Their architecture (domes and decorated flat surfaces) derived from Byzantium. The patio or enclosed court of their houses came from Rome; Their medicine was but a diluted or debased strain of Greek medicine.'[1415]

And on which Myers insists:

> 'Islam's rise in culture and science is closely connected with translating activities; as long as these persisted, Islam was

[1412] M.C. Lyons: Popular Science and Technology in Medieval Islam; *Scientia*; 101 (1966), pp. 50-5; at p. 54.
[1413] F. Sherwood Taylor: *A Short History of Science* (Heinemann, London, 1939), p.77.
[1414] Ibid; p.82.
[1415] F.H. Garrison: *Contributions to the History of Medicine* (Library of Congress Catalogue, New York, 1966), p.209.

motivated to reach for greater cultural heights. But when the decline of translation work set in, Islam's cultural leadership had run its course. What Islam had set out to do-to absorb other peoples' cultures by translation-had been achieved.'[1416]

Von Grunebaum stresses the Islamic genius in plagiarising:

'The tolerant attitude of Islam to the foreign material and its powers of assimilation are likely to create the impression of lacking originality. But Islam's originality consists exactly in the capacity of adapting the alien inspiration to its needs, of re-creating in its own garb, and of rejecting the un-adaptable. Islam can hardly be called creative in the sense that the Greeks were creative in the fifth and fourth centuries BC. Or the Western world since the Renaissance, but its flavour is unmistakable on whatever it touched; and while very little of its conceptual and not too much of its emotional contribution is new or unique.'[1417]

Myers, again:

'Islam ceased to make further progress in the sciences because it had reached the limit of its growth. Its greatness may have been due to intellectual precocity rather than to sustained leadership qualities; while Islam was still in its youth, it had the ingredients necessary for the phenomenal growth, but the days of exaltations had come to an end. Islam did not go beyond the achievements of Hellenistic mechanics; no new inventions of importance were made.'[1418]

At best, Islamic science is seen to be either mediocre, or plainly of negative influence. Bosworth, thus, insists on the mediocre standards of Islamic scholarship by praising Morgan:

'Dr Morgan, as editor, has a short but useful introduction contrasting the generalised backwardness of the research techniques of Islamic scholars.....'[1419]

Garrison speaks of the disastrous impact Islamic learning had on the Christian West:

'The way individual directives in training the student for the practice of his profession were wrong and wrong-headed at the

[1416] E. A. Myers: *Arabic Thought and the Western World* (Frederick Ungar Publishing, New York, 1964), p. 77.
[1417] G. E. Von Grunebaum: *Medieval Islam* (The University of Chicago Press, 1954), p. 324.
[1418] E. A. Myers: *Arabic Thought*; op cit; p. 77.
[1419] C.E. Bosworth review of D.O. Morgan, ed: Medieval historical writing in the Christian and Islamic worlds; London; SOAS; 1982, in (*Journal of Royal Asiatic Society*; 1985), p.78.

start, even down to the time of Sydenham. Dominated by what Osler calls 'The heavy hand of the Arabian.'[1420]

Renan goes even further, insisting how:

'The Muslim has the most profound contempt for learning, science, and all that constitutes the true spirit of the European.'[1421]

Lyons, once more, on the Islamic lack of faith in science:

'Sciences undoubtedly commanded respect (in Islamic society). An approving, if apocryphal, story is told of divine punishment in the form of a plague sent to punish the people of Athens for having neglected mathematics. An engineer who wrote books on his subject is noted as one of the distinguished men of his town and the same kind of approval is given to al-Farabi's chemistry. But it is worth remark that as far as al-Farabi is concerned chemistry is bracketed with music at the end of the list of his accomplishments and, in general, there is no comparison between the measure of praise devoted to men of science and that earned by experts in the traditional branches of learning, that is to say, literature, law and religion. These were the fields where great reputations were to be made and valuable rewards were to be won and as a result it is not surprising if they held the most attractions for men of ability. As for the scientists, on their own ground their popular reputation, to judge from Qazwini, lagged far behind that of such shadowy figures as Apollonius of Tyana, the maker of talismans. In such a climate of opinion their researches were either disregarded or else carried out under the awesome and doubtless inconvenient mantle of magic, this showing clearly enough that the general public at least were unable or perhaps unwilling to believe that the problems involved could be solved by human means.'[1422]

'The Muslim contempt for science,' Renan concludes, 'is so strong, because on conversion to Islam all races become one and the same. The Berber, the Sudanese, the Circasian, the Malay, the Egyptian, etc., are no longer Berber, Sudanese, Egyptians, etc, but Muslims.'[1423]

Although, a minority of Western historians disagree with these views, such views still represent the predominant Western impression and

[1420] F.H. Garrison: *Contributions to the History*, op cit; p. 94.
[1421] E. Renan: L'Islamisme et la Science; Conference at the Sorbonne given on 29 March 1883; in *Oeuvres Completes* (Calmann Levy; Paris; 1947), vol 1; p. 946.
[1422] M.C. Lyons: Popular Science; op cit; p. 55.
[1423] E. Renan: l'Islamisme; op cit; p. 946.

depiction of Islamic science and civilisation. And these views are found amongst those who give some space to Muslim sciences. Most Western historians of science and civilisation, indeed, completely set aside the period of the 'Dark Ages' (5th- 15th), which encompasses the period of Islamic scientific supremacy (7th-13th centuries), and jump from Antiquity (5th) to the Renaissance (late 15th), affirming that nothing of worth happened in those ten centuries.

Yet, as the following will amply show, mainstream Western depiction of history is fallacious in the extreme. The following chapters will address some of such fallacies in respect to the main sciences.[1424] In so doing, this work deviates sharply from the usual practice found in works and outlines on Muslim sciences, which devote a major part to Greek science, to acknowledge Western superiority, first, before presenting the Muslim scholar as a respectable pupil of his Greek master. The approach in this work is bound to displease the Eurocentric hordes, who also expect any writer on Muslim science to pepper their work with such inane expressions as Neo Galen, Neo Aristotle etc, even when the Muslim accomplishments are in total rejection of their Greek precedents; and as if any scientific achievement, from the earliest stages of history to our very day, in 2005, is nothing other than an amendment, improvement, or continuation of something started, or done before, somewhere else by someone else, and will continue to evolve. This work will, in fact, demonstrate how Islamic science, although using Greek learning as one of its sources, was by no means dependent, nor reliant on such Greek learning. It will show that, instead, it was the Islamic faith, which was at the basis, and the main source of inspiration for the rise of Islamic sciences, and that Greek learning, just as Hindu, and Chinese science served as a tool in the armoury of Muslim scientists.

As it progresses, this outline will also unveil a large variety of common fallacies found in the history of science, whether with regard to the inane theory of the 18th century agricultural revolution, or that technology is a product of the Western genius alone, or that modern maritime discoveries were due to the Western spirit of discovery, and so on and so forth.. This work will further deviate from the usual writing by focusing on issues and sciences that have tended to be ignored elsewhere, amongst the latter

[1424] This work relies nearly totally on Western sources despite the disparaging views many of them have for Islamic science. Moreover, as to be seen in the last part of this work, even the sources, which pay homage to Muslim scientific achievements, still are hostile to Islam as a faith.
Here follows a list of general works that deal with Islamic science and civilisation; more will be listed through the work:

being agriculture, nautical sciences, and engineering. Of course, it is impossible to say everything. Attempting to deal with all matters pertaining to Muslim sciences in detail is an endeavour of encyclopaedic dimensions much beyond this work and the competence of this author.[1425] The approach and methodology in dealing with each science will vary from one to the other. The sciences are covered in alphabetical order but they could have been covered in many other ways.

-J.Vernet: *Ce que la culture doit aux Arabes d'Espagne*, tr. by Gabriel Martinez Gros (Paris, 1985); German tr: *Die spanisch arabische kultur in Orient und Okzident* (Zurich/Munich, 1984).
-A. Djebbar: *Une Histoire de la Science Arabe* (Editions du Seuil; Paris; 2001).
-A. Mieli: *La Science Arabe et son role dans l'evolution scientifique mondiale* (Leiden: E.J. Brill. 1938).
-H.R. Turner: *Science in Medieval Islam* (Austin Texas, 1997).
-M. Vintejoux: *Le Miracle Arabe* (Charlot, Paris, 1950).
-D.R. Hill: *Islamic Science and Engineering* (Edinburgh University Press, 1993).
-J.W. Draper: *A History;* op cit; vol 2 in particular.
-I. and L. Al-Faruqi: *The Cultural Atlas of Islam;* op cit
-G. Sarton: *Introduction;* op cit.
-C.H. Haskins: *Studies in the History of Mediaeval Science,* (Frederick Ungar, New York. 1967).
-R. Briffault: *The Making of Humanity* (George Unwin and Allen, London, 1928).

[1425] An encyclopaedia of such sciences already exists: see R. Rashed edition: *Encyclopaedia of The History of Arabic Science*.3 Vols (Routledge, London-New York, 1996). This is an excellent work, but a much larger work is needed.

AGRICULTURE

Watson, who, without a doubt, wrote the best works on Islamic farming,[1426] in one of his shorter works, appropriately entitled 'A Medieval Green Revolution,' holds that:

> 'Arab geographers, authors of farming manuals, and other writers from the 10th century onward tell of great changes that came over the countryside of the early Islamic world either before or during their time. Most notably, many new crops were grown and new techniques of growing both old and new crops were introduced. Though unfortunate gaps in the available sources do not allow us to plot accurately the progress of these changes through time and space, it seems likely that their spread began at the time of the Arab conquests or shortly afterward and was largely completed by the end of the 11th century. By then, at any rate, agricultural changes had touched places far and wide, affecting to varying degrees, often profoundly, almost every part of the Islamic world. So impressive was the transformation of agriculture in so many regions that one is justified in using the term-alas, so hackneyed-agricultural revolution.'[1427]

Medieval Islamic farming, in all its dominant traits, methods and techniques, was much more advanced than that of the Christian West. It was also to remain so for centuries thereafter. More importantly, Islamic farming innovated in many areas, which were pioneering. Hence records show that cereal yields in Egypt were around 10 for 1, yields which were only to be obtained in Europe at the end of the 17th century.[1428] The diffusion of new crops and improved cultivation meant that fields that once yielded one crop yearly before, now yielded three or more crops in rotation; and agricultural products met the demands of an increasingly

[1426] Especially A.M Watson: *Agricultural Innovation in the Early Islamic World* (Cambridge University Press, 1983).
[1427] A. Watson: A Medieval Green Revolution: New Crops and Farming Techniques in The Early Islamic World, in *The Islamic Middle East 700-1900;* edited by A. Udovitch (Princeton; 1981), pp. 29-58; at p. 29.
[1428] In P. Guichard: Mise en valeur du sol et production: De la 'revolution agricole' aux difficultes du bas Moyen Age; In *Etats et Societes* (J.C. Garcin et al edition); Vol 2 (Presses Universitaires de France; 2000), pp. 175-99; p. 184.

sophisticated and cosmopolitan urban population, providing it with a variety of products unknown in northern Europe.[1429] Throughout the Islamic world, cities were supported by a very advanced farming system that included extensive irrigation works, expert knowledge of agricultural methods, the best orchards and vegetable gardens, the rearing of the finest horses and sheep, 'the most advanced system in the world,' says Artz.[1430] Arriving crusaders in the East were stunned at the sight of the coastal regions of Syria and Palestine; Tripoli and its surrounding covered in cultivated fields, and an abundance of orchards and gardens, vast plantations of sugar; citrus trees, banana plants, date palms... all thriving.[1431] Dunayat (in northern Syria) was lying on a vast plain, surrounded by sweet smelling plants and irrigated vegetable gardens, according to the same crusader account.[1432] Under Muslim rule, the south of Spain became a highly prosperous region, and as described by a poet quoted by Shack:

> 'Where the Arabs set foot on Spanish soil life and water sprang up, the sycamores, pomegranates, bananas and sugar cane intertwined in the glistening labyrinths, and even the very stones blossomed in gay colours.'[1433]

The al-Jaraffe district, to the West of Seville, in the 12th century, was, according to all accounts, covered in so luscious fruit orchards that 'the sun hardly touched the ground.'[1434] In that same country, such was the quality of produce some wheat could keep for a century in adequate storage conditions.[1435] In Sicily, Lowe holds, practically all the distinguishing features of Sicilian husbandry were introduced by the Muslims: citrus, cotton, carob, mulberry, sugar-cane, hemp, date palm, safron... the list is endless.[1436] Bresc, Glick and Castro also find that virtually all of the technical farming jargon of Spain and Sicily derives from Arabic.[1437] Such was the Muslim expertise that in Sicily, agriculture remained in Muslim hands under early Norman rule, and was, according to Scott 'carried to the

[1429] T. Glick: *Islamic;* op cit; p.68 ff.
[1430] F.B. Artz: *The Mind;* op cit; p.150.
[1431] P. Guichard: Mise en valeur; op cit; pp.175-6.
[1432] M. Erbstosser: *The Crusades;* op cit; p. 130.
[1433] *Poesie and kunst der Araber in Spanien und Sizilien* (Berlin; 1885), ii; p. 167.
[1434] E. Levi Provencal: *Histoire de l'Espagne Musulmane*; Vol III (Paris, Maisonneuve, 1953), p.275.
[1435] Ibid. 272.
[1436] A. Lowe: *The Barrier and the Bridge* (G. Bles, London, 1972), p. 78.
[1437] H. Bresc: *Politique et Societe en Sicile; XII-XV em siecle* (Variorum; Aldershot; 1990).
-A. Castro: *The Spaniards. An Introduction to their History.* trans. Willard F. King and Selma L. Margaretten, (The University of California Press, 1971).
-T. Glick: *Islamic*; op cit.

highest perfection.'[1438] This expertise meant that every plant or tree, whose culture was known to be profitable and which could adapt itself, was to be found in the gardens and plantations. Records were kept of the crops produced in each district; the methods of their disposition and the prices they brought were noted on the public registers; the breeds of horses, asses, and cattle were improved; and the greatest care was taken of them; and any food, which after experiment was found to be the most nutritious, was adopted.[1439]

This medieval picture of an accomplished Islamic farming sector did not prevent nearly all modern historians,[1440] from adopting the usual lines of denigration, a point raised by Cherbonneau:

> 'It is admitted with difficulty that a nation mostly of nomads could have known any form of agricultural techniques other than sowing wheat and barley. The misconceptions come from the rarity of works on the subject… If we took the trouble to open up and consult the old manuscripts, so many views would be changed, so many prejudices would be destroyed.'[1441]

Indeed, in their systematic and sustained effort to alter Islamic history, to suppress from it every single accomplishment, the majority of Western historians rewrite completely such history. Most often, regarding this subject, agriculture, one of the practices is to totally ignore the medieval period, doing away with centuries of history. If and when some such historians recognise Islamic accomplishments, they either demean them as much as possible, or simply misattribute them to others. In this latter instance, any sign of non-Islamic origin of agricultural accomplishments is exploited to levels as to even defy credible scholarship.

This matter of fallacies and demeaning Islamic accomplishments in the field is the first to be addressed in this chapter. As it proceeds, this chapter

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[1438] S.P. Scott: *History;* op cit; vol 3; p. 42.
[1439] Ibid.
[1440] With some exceptions other than those just mentioned, such as:
A.M Watson: *Agricultural Innovation in the Early Islamic World* (Cambridge University Press, 1983).
-T. Glick: *Islamic and Christian Spain;* op cit;.
-J. Vernet and J. Samso: Development of Arabic Science in Andalusia, in *The Encyclopaedia of the History* (Rashed ed), op cit, Vol 1, pp 243-76;
-T. Fahd: Botany and agriculture, in *Encyclopaedia* (Rashed ed) , op cit, vol 3 pp. 813-52.
-L. Bolens: L'Eau et l'Irrigation d'apres les traites d'agronomie Andalus au Moyen Age (XI-XIIem siecles), *Options Mediterraneenes*, 16 (Dec, 1972).
[1441] A. Cherbonneau: *Kitab al-Filaha* of Abu Khayr al-Ichbili, in *Bulletin d'Etudes Arabes*, vol 6 (1946); pp 130-144. at p. 130.

will reveal the pioneering and crucial contribution of Islamic farming to our modern agriculture, and thus will demonstrate that the assertion found in most history books that the agricultural revolution took place in the 18th century, and later in the West, is one of the most ridiculous found in history.

1. Historical Misinterpretations and Fallacies:

One of the established assumptions in historical writing is that, just before, or around, the early-mid 18th century, farmers in the English countryside initiated what is commonly known as the agricultural revolution. English landed classes, it is explained, were helped by the enclosure of land (began in 16th century), which gave them both security and institutional foundations to innovate. This led to widespread and critical changes such as crop rotation, improvements in animal husbandry, farm experiment etc… By the mid-late 18th century, English agriculture, it is explained, managed to release both surplus capital and labour for industry, and provide a wide enough market to give the foundation for industrial expansion, that so called Industrial Revolution that began in the late 18th century. Further changes (greater and better use of fertilisers, improved animal rearing, mechanisation, etc) in England and the rest of the Western world took place in earnest and, as time passed, reached a high momentum, completely reversing the picture that prevailed in past centuries, with poor food production now being replaced by large food surpluses. Simultaneously there was an equally momentous reversal on the wider international level, food purchasing orders now coming from the southern countries hardy able to feed their fast rising populations, whilst as recently as the 19th century, it was the opposite, France, for instance, purchasing wheat from Algeria.

The combined historical writing on agricultural change and the present state of southern dependency on Western food aid and supplies, result thus in the view that agricultural innovations and advances took place in the West. This view is totally misleading and fallacious, though. This chapter on Islamic farming will elaborate in great detail on the fact that nearly all innovations in modern agriculture were known and practiced in the medieval Islamic world. As summed up from Watson's medieval Green Revolution, Islamic agriculture got more produce out of the land by bringing more land under cultivation and by making old land much more

productive than in the past.[1442] It was highly capital intensive, and highly labour intensive; more capital being invested in the construction of irrigation works, terracing, providing seed and fertilisers, the reclamation of land, which also required heavy investment in labour, as well as in tools, animals and outbuildings. The introduction of new crops by the Muslims, as will be expanded upon, had the same effect of increasing production, productivity, higher investment of capital, labour, research, innovations (both on the ground and as recorded in treatises), and better use of the soil. The combination of all such factors brought former dead land into cultivation, and new irrigation techniques and systems also contributed to this.[1443]

These are some Islamic accomplishments, which mainstream history attributes to others, from whom, supposedly, the Muslims simply borrowed. For instance, Ashtor holds:

> 'The numerous accounts of these activities do not point to technological innovations within the irrigation system, which the Muslim rulers had simply taken over from their predecessors. The records in the writings of the Arabic historians show that those who drained the swamps and dug the canals were the Nabateans, not Arabs.'[1444]
>
> 'The information which the Arabic authors provide us in the methods of agricultural work, besides the irrigation canals and engines, is rather scanty. But collecting these records from various sources one is inclined to conclude that the Arabs did not improve the methods of agricultural work. There is only slight evidence of technological innovations in near eastern agriculture throughout the Middle Ages, whereas the history of European agriculture is the story of great changes and technological achievements.'[1445]
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> 'The Egyptian historian al-Makrizi says that the harvests had diminished so much under Moslem rule that it was necessary to put aside a quarter of even a third of the crop in order to render cultivation profitable.[1446] Undoubtedly the Arabic author had the later Middle ages in mind. But the decrease of the crops had probably begun a long time before he wrote. It was the

[1442] A. Watson: A Medieval Green Revolution; op cit; p. 43.
[1443] Ibid.
[1444] E. Ashtor: *A Social and Economic History of the Near East in the Middle Ages* (Collins; London; 1976), p. 46.
[1445] Ibid; p. 49.
[1446] Al-Makrizi: Khitat; op cit; Vol I; p. 101; 'quoted' by Ashtor.

> consequence of neglect, of old tired methods of cultivation, of heavy taxation and the attitude of a short sighted government.'[1447]

Once more, Ashtor is promoting fallacies, which the subsequent sections in this chapter will thoroughly demolish. With regard to the particular claim that Muslim agriculture was a mere copying of Nabatean farming, the following outline will show that nearly all Islamic innovations in farming were accomplished in the medieval period, thus, centuries apart from the Nabatean model. It will also show that they relate to this model hardly at all, and that, the faith itself, the expansion of Islam, besides experiment on the land, followed by recording such experiments in farming treatises, were the real foundations of the Islamic agricultural revolution.

As for Islamic farming being derived from Nabatean agriculture because the work of an early Islamic farming treatise by Ibn Wahshiya (860-ca 935) is entitled *Filaha Nabatiya,*[1448] there is no better way to answer this issue than Watson's following observation:

> 'A careful reading of the entire text has persuaded this writer (Watson) that a substantial part of the work was composed at the beginning of the 10th C. Only this dating makes it possible to explain extensive parts of the text; the references to Baghdad, Basra, Wasit and Kufa, all of which were to all intents and purposes founded in the Islamic period; the discussions of Islam and of the Arab conquest of Persia; and the frequent mention of new crops, unknown to the region of ''Babylonia" in Sasanian times. These sections are not, as suggested, a light overlayer in a text the greater part of which is more ancient. They are on the contrary, deeply embedded in the text and a fundamental part of it. Even the discussions of superstitions which were once thought to be much more ancient can sometimes be shown to belong to the time of Ibn Wahshiya.'[1449]

Islamic farming history, just like other aspects of Islamic history, also suffers from the generalised re-writing of history by Westerners, a rewriting which simultaneously suppresses the positive and enhances the negative. Looking at some aspects of Islamic history, we read, for instance, that 'the Muslim slave trade' was so excessively cruel that it forced Western nations to intervene, and colonise Africa to stop this most

[1447] E. Ashtor: *A Social*; op cit; p. 50.
[1448] Ibn Wahshiya: *Al-Filaha al-nabatiya* (Dar al-Kutub; Cairo); Ms. 490; I; pp. 173; 70.
[1449] A.M. Watson: *Agricultural Innovation*, op cit, p 219, note 1.

inhuman trade by the Muslims.[1450] In relation to Muslim Spanish history, we read that the Islamic presence was far from being an image of tolerance and civilisation,[1451] that only a few thousand Muslims were expelled from Spanish soil in 1609-1610,[1452] not millions as was accepted before,[1453] that the elimination of Muslims was necessary because they constituted a cancerous growth in the Spanish body,[1454] etc.. So, in relation to Spanish farming, for instance, it is hardly surprising to find new 'historians' such as Butzer and his group 'demonstrating' to us that the Muslims did not fundamentally alter the available range of cultivars and technology, and that if it might seem they brought changes to Spanish farming this was simply due to the fact that before them there was a catastrophic decline.[1455] Of course Butzer and his group are distorting facts. Had he and his group been right, that Islam had little to do with the changes in Spain, we would have found changes and transformations in agriculture in other places in Christendom equal in tenor to those taking place in Muslim Spain. Yet, this is not the case, whether in pre-medieval Western civilisations or in medieval Christendom. Nowhere do we find any advances comparable to those taking place in medieval Islamic Spain; advances, however, shared throughout the medieval Islamic land from the far east to the far west. Moreover, and specifically in relation to irrigation, as the Spanish vocabulary in the field demonstrates,[1456] and as Cowell notes, the Spanish Muslims skills in irrigation and in terracing, are said to have resulted in an agricultural productivity far beyond the wit of 'the relatively barbarous, less cultivated native Spaniards.'[1457] Finally, here, as will be abundantly shown in this chapter, the changes Muslims made in the field were not just dramatic; the Western agricultural revolution would incorporate such changes as rotation of crops, better use of fertilisers,

[1450] H.A.L. Fisher: *A History of Europe (From the Beginning of the 18th Century to 1937)* (Eyre and Spottiswoode; London; 1952), p. 1033.
The 'horrors' of the Muslim slave trade have been revived by the British channel Channel Four in 2003 in its programme on Empire as seen by this author on S4C; 18 February 2003; 12.10 am.
[1451] P. Conrad: *Histoire de la Reconquista* (Presses Universitaire de France; Paris; 1998).
[1452] H. Lapeyre: *Geographie de l'Espagne Morisque* (SEVPEN, 1959).
[1453] Such as by .S. Lane Poole: *The Moors;* op cit; p. 279.
[1454] R. M. Pidal: *Historia de Esapana dirigida por Ramon Menendez Pidal*' Vol 2 (Madrid; 2nd edition; 1966); p. 41.
[1455] K.W. Butzer et al: Irrigation agroecosystems in Eastern Spain: Roman or Islamic Origins? *Annals of the Association of American Geographers*; 75 (1985), p. 482 in particular.
[1456] See, for instance, A. Castro: *The Spaniards;* tr by W.F.King and S. Margaretten (University of California Press; 1971), pp. 256-8.
[1457] F.R. Cowell: *The Garden as a Fine Art* (Weidenfeld and Nicolson; London; 1978), p. 73.

experimental gardens, etc, only 5-6 centuries after the Muslim world, from the 16th century onwards.

The major problem one encounters with modern Western historians is that, in their systematised endeavour to re-write history, they not only contradict facts, and often themselves, and confuse history even more, they even contradict medieval Western writers who, even if hostile to Islam, at least recognised Islamic merits. This, again, is a pattern observed in all subjects as seen here in one or two instances. Hence, one of the early Western scientists to promote the use of reason against authority, Adelard of Bath (fl. Early 12th century), attributed his inspiration to his 'masters' the Arabs, in his *Quaestiones naturales*, saying explicitly: 'a magistris Arabicis ratione duce didici,'[1458] yet, modern historians, such as Lawn, insist that Adelard did not mean 'Arab,' his inspiration being Classical thought, instead.[1459] The translators of the 12th century, who also, without exception, stated that their dearest wish was to acquire the science of 'the Arabs,' and to transmit it to the West. Gerard of Cremona, the leading figure amongst such translators, for instance, and in front of the 'multitude' of Arabic books in every field, 'pitied the poverty of the Latin.'[1460] Modern historians, however, overwhelmingly insist that such translators aimed at the recuperation of 'Greek' learning, instead.[1461]
The same holds in relation to farming. Thus, whilst nearly all modern Western scholars demean the Islamic role, contemporary sources say the very opposite. As an indication of Muslim skill in matters of agriculture, Jeronimo Munzer, an important nobleman who travelled through Spain in the years 1494-5, when a great many Muslims still remained in Aragon, tells us:

> 'Among all the kingdoms of Spain, Aragon is without a doubt the one that has the greatest numbers of Moors, who are expert farmers. They pay a very high tax comprising the fourth part of their fruit, not counting other levies, and this is why the Spanish proverb says: he who owns no Moors has no gold.' In Aragon many towns are inhabited solely by Arabs and it is a remarkable

[1458] *Quaestiones naturales*, ed. M. Muller; BGPTM xxxi (1934) ii; quotation in J. Jolivet: The Arabic Inheritance; in *A History of Twelfth Century Western Philosophy;* Edited by P. Dronke (Cambridge University Press; 1988), pp.113-48. p. 113.
[1459] B. Lawn: *The Salernitan Questions* (Oxford at the Clarendon Press; 1963), pp. 21-2.
[1460] C.H. Haskins: *Studies in the History of Mediaeval Science* (Frederick Ungar Publishing Co. New York. 1967 ed), p. 14.
[1461] Such as F.L. Ganshof: The Middle Ages; in *The European Inheritance*, Ed: Sir. E. Barker, George Clark, and P. Vaucher, Vol I (Oxford, at the Clarendon Press, 1954), p. 413.
O. Pedersen: *Early Physics and Astronomy* (Cambridge University Press, 1974), p.339.

> thing that in some districts and territories where scarcely fifteen Christians could scrape a living, about sixty Moors live with ease; they have wonderful skill in the management of water and in the cultivation of the land, and as they eat very meagrely they accumulate considerable riches.'[1462]

And such was the Muslim superiority in farming skills, that following their mass elimination in the years 1609-1610, churches and land proprietors lost considerable incomes.[1463] Thus, the Duke of Grandia suffered especially from this; all the operatives in his sugar mills were Muslims, no one else knew the processes.[1464] In Ciudad-Real, the capital of La Mancha, the cloth industry was ruined.[1465] Even a large part of the kingdom of Valencia, the garden of Europe, was for years an inhabited wilderness. With the Muslim expulsion the knowledge of many arts, once the source of great profit, was hopelessly lost.[1466] The tabla de los depositos of Valencia-presumably a bank of deposit-was bankrupted, and the tabla of Barcelona, which was regarded as exceptionally strong, was likewise bankrupted.[1467] Such was the scale of the losses that the nobles were annually assisted by the king, as though they were in danger of starving. The Count of Castellar was awarded the sum of 2000 ducats a year, Don Juan Rotla 400, the Count del Real 2000, the Duke of Grandia 8000, and so forth.[1468]

One specific, and generalised, distortion found amongst Western historians is that Islamic irrigation techniques were a mere legacy from former civilisations. Thus, in his *Land behind Baghdad*, Adams draws the conclusion that the density of settlement in the Diyala Plains in Islamic times, as well as the extent of the irrigation system, never reached the high point of later Sasanian times in spite of considerable reconstruction in late Umayyad and early Abbasid times.[1469] His conclusions, however, as Watson points out, are based on inadequately collected data, such as his figures on taxation, which fail to take into account changes in rates of taxation, or efficiency of collection, and that his archaeological data is also inadequate due to his limited choice of samples, and so is Adams' incapacity to distinguish between the rural pottery of the Sasanian,

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[1462] J. Munzer: *Relacion de Viaje*; Ed Aguilar (Madrid; 1952), vol 1; p.415.
[1463] H.C. Lea: *The Moriscos of Spain* (Burt Franklin; New York; 1968), p.379.
[1464] Ibid; p.327.
[1465] Ibid; p.383.
[1466] S.P. Scott: *History*; op cit; vol 3; p. 321-2.
[1467] H. Lea: *The Moriscos of Spain*; op cit; p.371.
[1468] Ibid.
[1469] R. McC. Adams: *Land Behind Baghdad* (Chicago; 1965), pp. 84 ff.

Umayyad and Abbasid, shortcomings that impact directly on the wider picture and its relation to irrigation, and thus, render his conclusions wholly distorted.[1470]

Watson sums up and refutes many such distortions relating to Islamic irrigation:

> 'In the vast literature of irrigation history may be found assertions which tend to minimise or even discredit, the contribution of early Islamic times to the development of irrigated agriculture, particularly in Spain, North Africa and the Levant. Thus Ribera Y Tarrago, writing in a long tradition which belittles the Muslim legacy in Spain, argues that the irrigation system of the Huerta of Valencia is pre-Islamic, principally on the ground that it does not resemble the undoubtedly Muslim system in the region of Marrakech![1471] In North Africa, Gauckler, following the previous practice of European scholars writing on the region, assigned virtually all the ruined irrigation works of Tunisia to the Romans,[1472] an error the enormity of which was finally pointed out in Solignac, whose careful work is a model of this kind of investigation.[1473] In Libya, the qanawat (underground tunnels) of the desert were attributed by Beadnell to the Romans,[1474] whereas they are almost certainly Islamic. Again, for the Levant, one reads in Benvenisti that 'with the Arab conquest a period of decline and decay in irrigated agriculture began.'[1475] Such assertions need not be taken seriously. To prove for a particular region whether in early Islamic times irrigated agriculture had progressed beyond its classical antecedents requires very careful analysis, and the results may not be unambiguous.'[1476]

The following extensive look at Islamic irrigation and water management proves Watson's point, and shows how mainstream historical writing is thoroughly fallacious.

[1470] A. Watson: A Medieval Green Revolution; op cit; p. 53.
[1471] J. Ribera: *Dissertaciones y opusculos*, 2 vols (Madrid, 1928), vol 2; pp. 309-13.
[1472] P. Gauckler: *Enquete sur les Installations hydrauliques Romaines en Tunisie;* 2 Vols (Paris; 1901-2).
[1473] A. Solignac: Recherches sur les installations hydrauliques de kairaouan et des Steppes Tunisiennes du VII au Xiem siecle, in *Annales de l'Institut des Etudes Orientales*, Algiers, X (1952); 5-273.
[1474] H.J. Beadnell: *An Egyptian Oasis* (London; 1909), p 167 ff.
[1475] M. Benvenisti: *The Crusaders in the Holy Land* (Jerusalem; 1970), p.263.
[1476] A. Watson: *Agricultural*; op cit. Note 34, pp. 193-4.

2. Irrigation and Water Management:

A major accomplishment of Islamic civilisation was its legal code around water use and management. As Serjeant points out, a considerable part of most Islamic legal books is devoted to water law, a subject, which incidentally, he notes, has not been studied in Europe to any appreciable extent.[1477] This legalistic approach to the resource, once more, derives from the faith itself, the place of water in the Qur'an being one of the most predominant, a great number of verses touching upon it in one form or another. The Prophet himself had said much about rights to water and had settled many irrigation disputes, and from his sayings and rulings, worked over by later jurists, there emerged a substantial corpus of irrigation law which clearly established the rights of the parties involved in all sorts of disputes.[1478]

The Shariah, the Islamic system of law, distinguishes three types of water sources which may be the object of use and ownership: water from rivers, from wells, and from springs.[1479] In relation to water taken out of rivers, for instance, where it is possible to cause shortage to other users, by e.g. digging a canal to take water from higher up the river, or where damming or the allocation of fixed times is necessary to provide enough water for irrigation, in such case, the river is normally regarded as the joint property of the riparian cultivators, and the question of how much water may be retained by the highest riparian cultivator depends on differing circumstances, such as the season of the year, the type of crop irrigated, etc.[1480] In relation to springs, the Shariah states that if the water supply is limited, the first person to undertake irrigation in the area has the priority, otherwise water has to be shared equally.[1481] Throughout, though, Islamic legislation insists on providing water for free to those who are thirsty. Caliph Omar (Caliph 634-644) made some owners of water pay the diya (blood money) for a man who died of thirst after they had refused his request for water.[1482]

[1477] R. B. Serjeant: Agriculture and Horticulture: Some cultural interchanges of the medieval Arabs and Europe; in *Convegno Internationale: Oriente e occidente Nel Medioevo Filosofia E Scienze;* Aprile 1969 (Academia Nationale Dei Lincei; Roma; 1971), pp. 535-41. p. 537.
[1478] A. Watson: *Agricultural;* op cit; p. 28.
[1479] M.J.L. Young: Ma'; *Encyclopaedia of Islam*; vol 5; new series; p. 860.
[1480] Ibid.
[1481] Ibid.
[1482] Ibid.

Although this legislation did not always work towards the optimum economic use of land and water, Watson points out, it was a distinct improvement over the water law of pre-Islamic times of many of the regions affected. In much of pre-Islamic Arabia, for instance, water rights were usually established and transferred by force, and in many parts whole tribes exercised collective rights over wells.[1483] By enshrining individual rights and spelling these out in detail, Islamic law undoubtedly encouraged private investors.[1484] It also gave them the incentive to conserve water due to the benefits that might accrue from this resource.

Throughout the Muslim land, institutions were set up for the purpose of water management and distribution. In Damascus, the management of water was granted to the Sheikhs, that is the trusted and learned, leading figures of the city.[1485] In Fes, Morocco, the *qwadsiya* (workmen devoted to the maintenance of the *qadus*), that is the system of supply, were placed under the control of the Consul of water.[1486] Water disputes in that same city were the prerogative of a special committee composed of representatives from all groups of such users taking counsel from a mufti (learned religious figure).[1487] In Valencia, disputes and violations were the prerogative of a special court chosen by the farmers themselves, sitting at The Tribunal of the Waters on Thursdays at the door of the principal mosque (ten centuries later, the same tribunal was still sitting in Valencia, but at the door of the cathedral.)[1488]

Under conditions of water scarcity, Islamic society devised a complex system of distribution, in which technical knowledge played a central role. The division of water between several users was assured by a variety of mechanical devices, distributors, or runnels with inlets of a fixed size, and by the allocation of fixed periods of time.[1489] Where water is divided by a weir between a number of villages or users, the size of the weir varies according to the share of the water permanently allocated to the different users.[1490] During the period of water distribution, shares were defined in terms of days, hours, or minutes, and were allocated to the different districts, villages, fields, or plots of lands watered by the source in

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[1483] A. Watson: *Agricultural;* op cit; p. 28.
[1484] Ibid.
[1485] S. Denoix: Bilans in *Grandes Villes Mediterraneenes;* op cit; p. 294.
[1486] H. Ferhat: Fes; *Grandes Villes Mediterraneenes;* op cit; pp. 215-33; p. 225.
[1487] Ibid.
[1488] S.P. Scott: *History;* op cit; vol 2; pp. 602-3.
[1489] A.K.S. Lambton: Ma'; in *Encyclopaedia of Islam;* op cit; vol 5; p. 870.
[1490] Ibid.

question.[1491] In Spain and North Africa, the measuring was done in a variety of ways. For instance, a copper vessel with a hole pierced in it was placed in a tank filled with water; when the vessel itself was full and sank to the bottom of the tank, a stipulated fraction of the time share in the water was finished.[1492] When the water came from a basin with vertical sides, one could use a rule whose length was equal to the basin's depth and which was graduated, ie, it bore notches whose spacing corresponded to a given volume of water.[1493] Other methods are still in use. In the Beni Abbes region of Algeria, in the Sahara, south of Oran, for instance, farmers use a clepsydra to determine the duration of water use for every farmer in the area.[1494] This clepsydra times by the minute water use, night and day, throughout the year, taking into account seasonal variations. Each farmer is in turn summoned for his turn, and has to take necessary action to secure most efficient supply of water to his land.[1495] In Iran and Egypt, similarly, sand glass and water gate systems measured both time and volume of water used by each farmer. Leo the African speaks of the filling of water clocks when they are empty at the end of the irrigation time.[1496] In Spain, in the Valencia region, Glick elaborates on a complex distribution system of the waters of the River Turia, divided into successive stages, each stage representing the point of derivation of one main canal which drew all the water at that stage, or of two canals, dividing the water among them. At each stage the river was considered to hold twenty-four units of water.[1497] In times of abundance, each canal drew water from the river according to the capacity of the canal; in times of drought, the canals would take water in turn, for a commensurate number of hours or a proportional equivalent.[1498] The same was true for individual irrigators; and herein lies the genius of the Valencia system, Glick notes: when the canal ran full, each irrigator could open his gate as he pleased, but when water was scarce, a system of turns was instituted. Each irrigator, in turn, drew enough water to serve his needs, but could only do so when every other irrigator in the system had taken his turn, hence insuring a relatively equal distribution of supply, both in times of abundance and of scarcity.[1499] In general, the scarcer the water, the more detailed and

[1491] Ibid.
[1492] Editor: Ma'; in *Encyclopaedia of Islam*; op cit; p. 878.
[1493] Ibid.
[1494] L. Goonalons: La Clepsydre de Beni Abbes, in *Bulletin d'Etudes Arabes,* vol 3 (1943), pp. 35-7.
[1495] Ibid; p.37.
[1496] G. Wiet et al: *History*; op cit. p. 312.
[1497] T. Glick: *Islamic*; op cit; p.71.
[1498] Ibid.
[1499] Ibid.

complicated the distribution, and the greater the fragmentation of ownership of the water, the more meticulous and elaborate the organisation of its distribution.[1500] In the case of qanats, the rotation period could be lengthened in periods of water shortages, and the amount of water per share reduced.[1501]

A decisive contribution of Islamic civilisation was to seize on the existing, pre-Islamic systems, and bring them to advanced levels, most of which have survived to our day. The old, decayed systems were repaired, and new networks were constructed.[1502] Iraq, for instance, on the eve of the Muslim conquest, suffered from neglect of irrigation, exploitative taxation and crippling wars with the Roman Empire.[1503] In southern Iraq, before Islam, the irrigation works were allowed to degenerate, and in the years 627-8, on the eve of the Muslim conquest, a major agricultural disaster took place, which was followed by disastrous floods of the Tigris river which burst its dikes.[1504] Soon Muslim rule provided stable government and major hydraulic works were carried out, including drying swamped lands, reclamation of salt marshes, and new irrigation schemes put in place in the Upper Euphrates region.[1505] There was vast reconstruction work of irrigation systems under the viceroy Hajjaj (d. 714).[1506] In the Diyala Plains, at least, and probably over a much larger area, the restoration and reconstruction of Sasanian irrigation works took place through the late 8th and early 9th centuries.[1507] In Egypt, the work of bringing back into cultivation abandoned lands was begun by Qurra Ibn Sharik in 709-14, and continued throughout most of the 8th and much of the 9th centuries, and in Spain, we learn of the same initiatives.[1508] At the same time, land, which had never before been irrigated, or cultivated, or which had been abandoned, was provided with irrigation systems.[1509] There is evidence for the extension of irrigated farming from practically every part of the Islamic world in the early centuries of Islam.[1510]

[1500] A.K.S. Lambton: Ma'; in *Encyclopaedia of Islam*; op cit; vol 5; p. 870.
[1501] Ibid.
[1502] A.M. Watson: *Agricultural Innovation,* op cit; p. 104; and pp. 109-10.
[1503] I.M. Lapidus: *A History of Islamic Societies* (Cambridge University Press; 1998), ed; p.46.
[1504] Ibid.
[1505] Ibid.
[1506] A.M. Watson: A Medieval: Op cit; p. 39.
[1507] Ibid.
[1508] Ibid.
[1509] Ibid.
[1510] Ibid.

As they expanded vastly, the surface of irrigated lands, Muslims devised new techniques so as to catch, channel, store and lift the water (through the use of norias (water lifting devices), whilst new ingenious combinations of available devices were put in place.[1511] Rainwater was captured in trenches on the sides of hills or as it ran down mountain gorges or into valleys; and surface water was taken from springs, brooks, rivers and oases, whilst underground water was exploited by creating new springs, or digging wells.[1512] The Muslims also dammed more rivers, and improved irrigation by systems of branch channels.[1513] Engineering expertise remained central indeed to the system, one account telling how a mountainside near Damascus was tunnelled through to allow the passage of a stream.[1514] Distribution of water was also adapted to every soil variety, two hundred and twenty four of these, each with a name,[1515] and each with its water requirements. Techniques were also adapted to specific natural conditions.[1516] The impact was obviously to make irrigation more economical, and to make lands hitherto unused productive.[1517]

Like every dominant aspect of Islamic civilisation, the practical and the scholarly were once more brought together in a vast literature devoted to matters of water, its use, management, storage, and preservation. All *Kitab al-Filahat* (Book of Agriculture), whether North African, Andalusian; Egyptian, Iraqi, Persian or Yemenite, Bolens says,[1518] insist meticulously on the deployment of equipment and on the control of water.[1519] Thus, Abu'l Khair (fl early 12th century) of Seville, the author of a book on farming (*Kitab al-Filaha)* proposes four ways to collect rain water, and

[1511] A.M. Watson: *Agricultural Innovation*, op cit; p. 104; and pp. 109-10.
[1512] Ibid; p. 107.
[1513] R.J. Forbes: *Studies in Ancient Technology*; vol II, second revised edition (Leiden, E.J Brill, 1965), p. 49.
[1514] M.C. Lyons: Popular Science; op cit; p. 52.
[1515] S.P. Scott: *History*, op cit; vol 2; pp. 602-3.
[1516] E. Levi Provencal: *Histoire; op cit;* vol iii, p. 279.
[1517] A.M. Watson: *Agricultural Innovation*, op cit; p. 104.
[1518] L. Bolens, Irrigation; in *Encyclopaedia of the History of Science, Technology, and Medicine in Non Western Cultures*, edited by H. Selin (Kluwer Academic Publishers. Boston/London, 1997), pp. 450-2; at p. 451.
[1519] Most particularly:
-Ibn Al-Awwam: *Le Livre de l'Agriculture* d' Ibn al-Awwam, tr. from Arabic by J.J. Clement-Mullet, Vol. I (Paris 1864).
-Ibn Bassal: *Libro de agricultura*, Jose M. Millas Vallicrosa and Mohammed Azinan eds, Tetuan: instituto Muley al-Hasan (1953).

other artificially obtained waters.[1520] He recommends such recovery for growing olive trees, and also explains techniques for maintaining soil moisture.[1521] In his treatise, Ibn al-Awwam (fl Seville end of 12th century), speaks at length of the watering process for each crop; in the case of rice, for instance, offering advice for each stage, before planting, after, and also irrigation and drainage once the crop has grown.[1522] Ibn Mammati (d. 1209) implied that in areas where year-long irrigation was available summer crops might be grown after winter crops and income would thereby be doubled.[1523] Other treatises deal with the same subject, and include Ibn Wafid's (d.1074) *Majmu' fi'l Filaha* (Compodium of Agriculture); Ibn Hajjaj (fl 11th century) *Al-Muqni fi'l Filaha* (the Satisfactory Book of Agriculture); and Al-Taghnari (12th century): *Kitab Zahrat al Bustan* (Book of the Flowers of the Garden).

The same literature also gives good focus to engineering works aimed at the storage and supply of the resource. Ibn Mammati suggests that the construction of a retaining dam on the Alexandrian canal and the consequent provision of perennial irrigation on lands lying below the dam would achieve an increase in income.[1524] A particular interest is given to the Qanat system, that is the underground water system, which conducts water from its source to a distant location.[1525] In Iraq Al-Kharaji (11th cent) wrote *Inbat al-miyah al-khafiyya* (The Extraction of Hidden Waters), describing not only the application of geometry and algebra to hydrology but also the instruments used by master well diggers and qanat builders.[1526] The work deals with surveying instruments, methods of detecting sources of water and instructions for the excavation of underground conduits.[1527] It devotes various chapters to specific issues, such as notes related to underground water (chap 3); description of mountains and rocks which reveal the presence of water (chap 4); study of grounds with water (chap 5); plants that signal the presence of water (chap 6); description of dry mountains and arid soils (chap 7); on the variety of waters and their tastes (chap 8); how to purify polluted waters (chap 10)

[1520] Abu'l- Khair Kitab al-Filaha; in V. Lagardere: *Campagnes et paysans d'Al Andalus* (Maisonneuve; Larose; Paris; 1993), at p. 265.
[1521] Ibid.
[1522] Ibn Al-Awwam: *Le Livre de l'Agriculture;* op cit.
[1523] Ibn Mammati; p. 221 in A. Watson: *Agricultural*; op cit; Note 37; p. 204.
[1524] Ibid.
[1525] P. Guichard: Mise en valeur; op cit; p. 181.
[1526] D. R. Hill: *Islamic Science*, op cit, p. 187-91.
[1527] Ibid.

etc.[1528] There is also an anonymous work, also from Iraq: *Kitab al-hawi li l-a'mal al-sultaniyya wa rusum al-diwaniyya* (Book Comprising Public Works and Regulations for Official Accounting).[1529] Cahen has published the part of this treatise dealing with irrigation.[1530] It includes large extracts on norias, *gharrafas* and other water raising machinery; sections on instruments, techniques of levelling and canals, and their digging, water retention structures, etc.[1531]

The Qanat, already mentioned above, consists primarily of a series of vertical shafts, resembling but not acting as wells, constructed along the line of the qanat to allow access for maintenance and removal of spoil.[1532] The qanat system allows the sound management and protection of a scarce and precious resource from evaporation. It also helped, Guichard notes, to stimulate the prosperity of whole regions that would otherwise have remained barren.[1533] Oliver Asin in this *Historia del nombre Madrid* seems to have presented a good case for the Muslims having made it possible to develop what has become the city of Madrid by introducing a sort of qanat system to supply the district with water.[1534] Parts of this apparently still exist, and Asin links the actual name Madrid to it.[1535]
The management of the qanat system was also complex, and like other forms of water uses, followed the same strict rules and regulations. In Iraq, for instance, a whole 'Water Service' was devoted to the task of supervision and maintenance, and an army of functionaries and other personnel was also involved.[1536] The qanats were also scrupulously policed, and maintained, with references to skilled personnel, and even of diving teams.[1537]
The qanat system has survived to this day in many parts, including in the Algerian Sahara, under the name Fogarras, modern Spain, and diverse

[1528] A. Mazaheri: Le Traite de l'exploitation des eaux souterraines de al-Karagi; Correspondence, in *ARCHEION,* 18; pp. 300-1.
[1529] D.R. Hill: *Islamic Science*, op cit, pp 187-91.
[1530] Claude Cahen, 'Le Service de l'irrigation en Iraq au debut du XIe Siecle,' *Bulletin d'Etudes Orientales*, Vol 13 (1949-51), 117-43.
[1531] Ibid.
[1532] K. Sutton: Qanats in al-Andalus; the continued presence of Moorish irrigation technology in the Campo Tabernas, Almeria; Spain; *The Maghreb Review*; vol 26; 1 (2001), pp. 69-78; at p. 70.
[1533] P. Guichard: Mise en valeur; op cit; p.181.
[1534] R. B. Serjeant: Agriculture and Horticulture; op cit; p. 537.
[1535] Ibid.
[1536] P. Guichard: Mise en valeur; op cit. pp.181-2.
[1537] G. Wiet et al: *History*; op cit; p.312.

parts of the South American continent, where it had a substantial impact on the local farming.[1538]

Islamic irrigation and water uses, it must be finally pointed out, are owed to the particular legacy of the Yemen. Serjeant insists that the Yemen was the province which had the most highly developed irrigation systems, terraced mountain sides running from the top to the foot of high mountains, great masonry cisterns, and skill in the control of flood waters that may be unequalled.[1539] The Yemenis who came to settle in Egypt, the Maghrib, and Spain, also brought with them their irrigation laws and administration.[1540] And so many south Arabs, to judge by their names, Tujibi, Himyari, Kindi, Ma'afiri, settled in Spain, that it is attractive also to think that they may have influenced the development of the mountain districts of Spain.[1541]

This legacy from the Yemen and other cultures, developed and advanced by the applications of the summons of the religious text, and the works of a large group of ingenious experimenters and scholars, was passed on to the Christian West. Witness of such impact is the considerable Arabic vocabulary in Spanish irrigation (acequia, alberca, arcaduz, noria etc,) for instance.[1542] Another aspect is in the prevalence of Islamic techniques: norias, saquias etc, and not just in Spain and Portugal, but also in their American colonies.[1543] In Majorca, there still remain extensive tank irrigation schemes constructed by the Muslims.[1544] Remains of Islamic water systems can also be seen in the surviving dams; many such dams as on the Turia River now over ten centuries old, still meeting the irrigation needs of Valencia, and so effective that they require no addition to the system.[1545] There was a similar impact in Sicily, where the study of philology clearly highlights the Arabic etymology of Sicilian vocabulary related to irrigation.[1546]

[1538] K. Sutton: Qanats; op cit; pp 72 fwd.
[1539] R. B. Serjeant: Agriculture and Horticulture; op cit; p. 537.
[1540] On the Yemeni impact in various parts, see, for instance: H.T. Noris: The Yemenis in the Western Sahara; *Journal of African History*; iii (1962): pp. 317-22; On the Yemeni influence on irrigation works in Muslim Spain, see: T. Glick: *Irrigation and Society in Medieval Valencia* (Cambridge; 1970), pp. 177; 186; 214-5; 230.
[1541] R.B. Serjeant: Agriculture; op cit; p. 537.
[1542] M. Watt: *The Influence,* op cit, pp 22-23.
[1543] D.R. Hill: *Islamic Science*; op cit; T. Glick: *Islamic;* op cit; K. Sutton: Qanats; op cit;
[1544] In *Encyclopaedia Britannica*; ed. XI; 17, p. 451.
[1545] N. Smith: *A History of Dams* (The Chaucer Press, London,1971), p.93.
[1546] H. Bresc: Les Jardins de Palerme; in *Politique et Societe en Sicile: XII-XV em siecle* (Variorum; Aldershot; 1990), pp. 55-127; p. 67.

3. Land Use and Management:

Just as with water, the arrival of Islam considerably altered land ownership, and more crucially, land use. Islam legalised individual ownership of the land in contrast to tribal institutions which made the *hima* (the land which was kept as a preserve, sacred territory, or land reserved for the exclusive use of a tribe or a tribal chief) common to all members of the tribe.[1547] By furthering concepts related to land reclamation and distribution, Islam transformed the Arabs from nomadic people into a civilisation of land owners.[1548] Although this Islamic conception of land ownership was connected with the actual possession of the land, it did not preclude the other concept that property is God's to give, and so is the land, and that people can use and exploit both.[1549] Individual ownership of the land was, however, neither absolute nor unconditional, for Islam laid down some regulations, which limited its absolute character.[1550] Since the concept of ownership was to encourage people to make use of land, and since land was granted for both individual and communal benefit, the right of ownership would cease to function if the cultivation stopped.[1551] Accordingly, both the Prophet and Caliph Omar (Caliph 634-644) took back land which had been granted to some of the Companions who were unable to exploit it. Omar took back from Bilal ibn Al-Harith al-Muzni some of the land that the Prophet had granted to him, saying:

> 'God's messenger has not granted you this land so that you should merely prevent other people from holding it: he granted it to you in order to work it. Take whatever you can cultivate, and return the rest.'[1552]

In respect to conquered land, the same Caliph is also noted for his attitude to land ownership and rights. Following the conquest of Egypt, he rejected the advice of Zobeir to divide the land amongst his followers. 'Leave it,' said Omar, 'in the people's hands to nurse and to fructify.'[1553]

[1547] A. Abd Al-Kader: Land Property and Land Tenure in Islam; *The Islamic Quarterly*; Vol 5 (1959), pp. 4-11; at p. 1 and 11.
[1548] Ibid; 11.
[1549] Ibid.
[1550] Ibid.
[1551] Ibid.
[1552] Al-Amwal: p. 290; in A. Abd Al-Kader; p. 5.
[1553] Sir W. Muir: *The Caliphate* (Smith and Elder and Co; London; 1883), p. 170.

The Muslims, Durant notes, could have devastated or confiscated everything, like the Mongols or the Magyars or the raiding Norse; instead they merely taxed.[1554] Conquered lands, while forming a part of the public domain, could not be acquired by those who had conquered them, and continued to be occupied and tilled by their former proprietors.[1555]

The arrival of Islam altered the condition of the land in further respects, which were amenable to better use and higher economic returns. Following Muslim rule, Le Strange notes, lands of the realm were measured, records were systematically kept, roads and canals were multiplied or maintained, rivers were banked to prevent floods; Iraq, formerly half desert, was again a garden of Eden; Palestine, recently so rich in sand and stones, was fertile, wealthy and populous.[1556] Purely Islamic regulations and statutes played the central role in this. Among the rights which were acknowledged by Islam for the purpose of individual land ownership is the reclamation of waste land, defined as land without any owner, and without any trace of cultivation or development.[1557] According to one of the Muslim jurists, Abu Hanifa, ownership only holds if the former owners are unknown, and this ownership through reclamation becomes established only when the reclaimer begins the process of reclaiming it by cultivation or digging it, or surrounding it with walls, but if he ceases to work it, he would only have priority but not ownership, and he stipulates a period of three years as a proof of working.[1558] However, Caliph Omar, once more, cancelled the practice of placing a stone or digging a ditch around a piece of land, prohibiting reserving any part of it.[1559] The Islamic jurist Al-Shafi'i explains that if the ruler grants a piece of land, or if someone reserves for himself a piece of dead land and prevents anyone from developing it, the ruler has the right to tell such person that if he develops such land, it is his, if not, it will be taken from him and given to another Muslim who would be willing to develop it.[1560]

As will be expanded under another heading further on, the Islamic legal corpus also gave great incentives to land improvement. One such incentive was in exempting or taxing at only half the normal rate lands planted with permanent crops which had not yet begun to yield, which, no

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[1554] Will Durant: *The Age of Faith*, op cit; p.227.
[1555] S.P. Scott: *History*; op cit; Vol 1; p.130.
[1556] G. Le Strange: *Palestine Under the Moslems* (London; 1890), p. 24.
[1557] A. Abd Al-Kader: Land Property; op cit; p. 6.
[1558] Ibid.
[1559] Ibid; p. 11.
[1560] Al-Umm; iii; p. 271. in A. Abd Al-Kader; op cit; p. 7.

doubt encouraged investment in tree crops, such as bananas, citrus, mangoes and coconut palms, which ultimately yielded far higher returns than the traditional crops.[1561]

Security of ownership, the obligation to improve estates, and the measures just seen, all gave the incentive to Muslim farmers to innovate. One principal way this worked was by the introduction of new crops (which will be elaborated upon further on), which had a dramatic impact on land use. This was accomplished by planting such new crops on hitherto dead lands. Sorghum, for instance, though requiring moderate amounts of water around and after planting time, produces best results in a dry heat, whilst watermelons and eggplants can also give satisfactory yields with very little water.[1562] Some of the crops were useful in pushing back the frontiers of dry farming into areas which in earlier times had been considered too hot, too arid, too infertile to be cultivated regularly or at all, sorghum, once more, doing very well on hard, sandy soils, inhospitable to other crops, even improved the quality of such soils.[1563] Hard wheat, and watermelons could grow on sandy soils, whilst sugar cane, coconut palms, colocasia and eggplants could be grown on saline soils, and thus, they made it possible to expand cultivation onto swampy lands along sea-coasts, the mouths of rivers, into lands watered by brackish water, and into lands that after centuries of cropping had become too salty for other crops.[1564]

Soil enrichment remained a central concern to Muslim farmers, and this was accomplished through a variety of techniques and methods. Soils were enriched by varying methods of ploughing (normal and deep), hoeing, digging and harrowing.[1565] Bresc states that farms of Norman Sicily, which were still probably in the hands of Muslim cultivators, were ploughed four times before planting.[1566] Turning and breaking the soil were seen as partial substitutes for both fallowing and fertilising, and on occasions preferable. Throughout the Muslim world, fertilisers of all sorts were also used and employed in accordance with much advanced farming requirements.[1567] Animal dung was widely used, and so was vegetal matter of many sorts, including sediment from olive oil, lees, straw, husks,

[1561] A.M. Watson: *Agricultural;* op cit; p. 28.
[1562] A.M. Watson: A Medieval Green Revolution; Op cit; p. 41.
[1563] Ibid.
[1564] Ibid.
[1565] A..M. Watson: *Agricultural*, op cit, chapter 23.
[1566] H. Bresc: Les Jardins; op cit; p.69.
[1567] T. Glick: *Islamic*, op cit, p. 75.

leaves, and mineral matter such as different kinds of oils, chalk, marl, crushed bricks, etc.[1568] The geographer, Yaqut al-Hamawi (d.1229), for instance, informs us that the town refuse of Basra was systematically brought as manure to the sugar cane.[1569] Watson remarks that the range of fertilisers used by Muslims was much larger than in ancient traditions, and that the fact that night soil was used was of great importance since it made available very large supplies of a fertiliser not used in European agriculture, and thus reduced or eliminated the need to pasture animals on fields.[1570] It seems likely, Watson adds, that it is for this reason that communal rights to graze on stubble did not develop in the Islamic world, and hence the rigid village wide rotation of medieval Europe did not appear. Muslim cultivators, were thus, left free to develop rotations which suited both soil, moisture, and market conditions.[1571] Many techniques and methods for upgrading different types of soils were also implemented, including the use of special crops to increase soil fertility.[1572] Sorghum, trimester wheat, legumes, beets, sugar cane, rice, various grasses and many other crops were appropriately designed for the enrichment of specific kinds of soils.[1573] One other way in which Islamic farmers were able to increase soil productivity was through a closer matching of crops to soil, climate and water, and in doing so, they had more scope than their predecessors, for they had more crops to choose from, the old ones, new strains from them, and also the new crops, which the Muslims introduced.[1574]

The Muslim farmer also understood the requirements of these crops better than his predecessors, identifying many different kinds of soils, each suited to particular kinds of plants, and differentiating them further by taking into account the soil's moisture and temperature through the growing season.[1575] The Muslim farmer also had a more sophisticated understanding of the effects of climate on plant growth, which took account not only of rainfall and air temperature but also the effects of various winds.[1576] Thus, the Muslim farmer was informed how barley

[1568] See L. Bolens: Engrais et protection de la fertilite dans l'agronomie Hispano-Arabe au XI-XIIem siecles; *Etudes Rurales*; XLVI (1972), pp. 34-60.
[1569] Yaqut al-Hamawi: *Dictionaire de la Perse*; ed. Barbier de Maynard (Paris; 1881), p. 294.
[1570] A.M. Watson: A Medieval Green Revolution; op cit; Note 36; p. 54.
[1571] Ibid.
[1572] A. Watson: *Agricultural*; op cit; Note 29; p. 203.
[1573] Ibid.
[1574] A.M. Watson: A Medieval Green Revolution; op cit; pp.42-3.
[1575] Ibid.
[1576] Ibid.

could grow in lands where wheat does not, and how it succeeds in soils that are saline, fine, soft, loose, weak, seeping and perspiring; or that the lime tree likes loose earth with a little salinity or red, aerated earth.[1577] Soils were also protected from erosion, especially in the delicate environments that formed the Islamic geographical space.

Islamic farming treatises provided a significant amount of knowledge in relation to land use, management, and soil improvement. Ibn Wahshiya remarks that 'the earth does not keep form but changes over time,' and changes in the quality of the soil,' he adds, 'this could be effected by the cultivator.'[1578] He proposes many treatments for earths categorised as saline, sweet, bitter, acid, foul, delicate, clayish, sharp, heavy, and astringent, treatments, which often involved the addition of various kinds of oils, appropriately chosen, as well as the right kind of animal and green manures, correct watering, much ploughing, and the choice of suitable crops in the early years of cultivation.[1579] Ibn Bassal, in his book on farming, distinguishes between ten classes of soil, each assigned with a different life sustaining capability, according to the season of the year.[1580] He is insistent that fallow land be ploughed four times between January and May and, in certain cases (for example, when cotton is cropped in the thick soil of the Mediterranean coast), he recommends as many as ten ploughings.[1581] Ibn Bassal's countrymen, Ibn al-Awwam did not neglect the crucial issue in Islamic farming of soil salinity,[1582] whilst Al Ichbili's *Kitab al-Filaha,* explains the required soils for each crop, tasks preceding planting, soil preparation, use of manure, ploughing techniques, their frequency, soil preservation etc.[1583] Al-Maqrizi and Ibn Mammati, for their part, explain the forms, manners and frequencies of ploughing in sugar cane farm-lands.[1584] Ibn Mammati says that land to be planted with summer crops should be ploughed two or three times.[1585] Whilst some such techniques were possibly uneconomic, many, however, permitted

[1577] Ibn Wahshiya: *Al-Filaha al-nabatiya* (Dar al-Kutub; Cairo), Ms. 490; I; pp. 173; 70.
[1578] Ibid; p. 128.
[1579] Ibid; pp. 127 fwd.
[1580] In Millas Vallicrosa, 'Sobre la obra de agricultura de Ibn Bassal,' in *Nuevos estudios sobre historia de la ciencia espanola* (Barcelona: Consejo Superior de Investigaciones Cientificas, 1960), pp 139-40.
[1581] Ibid.
[1582] Here from the Spanish translation in 1802 in two volumes was the work of Don Josef Antoine Banqueri, 1; 69 fwd; and ii; p. 5.
[1583] In A Cherbonneau: *Kitab al-Filaha of Al-Ichbili,* op cit.
[1584] Al-Maqrizi; Khitat 1; pp.182-3, and Ibn Mammati. P. 266 In A. Watson: *Agricultural*; op cit; note 26; p. 203.
[1585] Ibn Mammati, 245-6 in A. Watson: *Agricultural*; op cit; note 26; p. 203.

vast improvements to the soil quality, and allowed a vaster use of dry land and expansion of Islamic agriculture into lands hitherto uncultivated.[1586] Such was the care for soil, as for water, both understood by early Islamic society as precious resources. Islamic farming, Bolens insists, followed 'the golden rule of ecology,' and was 'subject to laws of scrupulously careful ecology.'[1587]

4. Farming Science:

According to Bolens, Muslim farming owed its success to:

> 'The adoption of agrarian techniques to local needs,' and to 'a spectacular cultural union of scientific knowledge from the past and the present, from the Near East, the Maghrib, and Andalusia. A culmination more subtle than a simple accumulation of techniques, it has been an enduring ecological success, proven by the course of human history.'[1588]

This success followed two guiding principles: experimentation, and diffusion of acquired knowledge. Levi Provencal observes that Muslim farming literature although suffering an unjust neglect on the part of scholarship, is the only literature which has a 'flavour of the land.'[1589] Ibn Wahshiya quarrelled openly with earlier authorities when their recommendations were not borne out by experiment.[1590] Ibn Bassal, who was gardening in Toledo when it fell to Christian conquerors in 1085, wrote almost exclusively from his own direct experience.[1591] Ibn al-Awwam writes, 'I affirm nothing which seems right to me without having proven it in numerous experiments.'[1592] For this purpose he cultivated a short distance from Seville, a farmland called 'Alxarafe'.[1593] His *Kitab al Filaha* (Book of Agriculture) was a culmination of both practice and

[1586] A.M. Watson: A Medieval Green Revolution; op cit; p. 41.
[1587] L. Bolens: Agriculture, in *Encyclopaedia* (Selin ed), op cit, p. 22.
[1588] Ibid; p. 20.
[1589] E. Levi Provencal: *Histoire;* op cit; p. 264.
[1590] A.M. Watson: A Medieval Green Revolution; op cit; p. 43.
[1591] F.F Armesto: *Millennium* (Simon and Shuster; 1995), p.37.
[1592] L. Bolens: Agriculture, in: *Encyclopaedia* (Selin ed) *op cit;* p. 21.
[1593] Ibn Al-Awwam: in *Biographie Universelle*: New Edition, published under the direction of M. Michaud (Paris, 1857), Vol XX: pp 267-8.

observation, and of high technical interest.[1594] Relying on his own experience, Ibn al-Awwam covers a wide diversity of subjects,[1595] studying up to 585 plants, the cultivation of fruit trees, grafting, soil properties, manure, and plant diseases and their treatments.[1596] He also studies irrigation, affinities between trees, animal husbandry and bee keeping.[1597] In his treatise are also found plants now extinct, as well as traditional agricultural practices now phased out.[1598] And far from being dated, in the late 19th century, that is eight centuries after it was completed, it was deemed relevant to the Mediterranean farming environment, and so was published in both Spanish and French.[1599] Ibn al-Awwam's countryman, Ali Ibn Farah, also experimented with botanical gardens in the most inaccessible parts of southern Spain, and created a botanical garden in Guadix.[1600] In Sicily, Bresc notes, the many techniques described or suggested in the contracts of the 14th and 15th century were found in Muslim farming manuals.[1601] Many ploughing methods to prepare the soil, the use of fertilisers, planting, etc, are also found to be shared by Sicilian agriculture and such manuals.[1602] It is the sort of information found in Al-Ichbili's *Kitab al-Filaha,* which goes into minute detail on how to grow olive trees, treatments for tree diseases, grafting, harvesting olives, refining olive oil, conditioning of olives, etc; or cotton, its required soil properties, soil preparation, use of manure, ploughing techniques, the time of the year for planting, irrigation, care for plants, harvesting etc.[1603]

A major contribution to the advance of farming was the focused study by such farming manuals on specific crops. This is highlighted here with respect to cotton,[1604] sugar cane,[1605] and rice.[1606] Cotton is sometimes

[1594] Baron Carra de Vaux: *Les Penseurs de l'Islam* (Paris, Librairie Paul Geuthner, 1921), vol 2; p. 301.
[1595] Ibn Al-Awwam: *Le Livre de l'Agriculture*, op cit,.
[1596] P.K. Hitti: *History of the Arabs* (MacMillan, London, 1970), p. 575.
[1597] Baron Carra de Vaux: *Les Penseurs*; op cit, pp. 300-6.
[1598] Ibn al-Awwam in Bibliographie Universelle; op cit.
[1599] J. Vernet and J. Samso: Development of Arabic Science in Andalusia, in *The Encyclopaedia(Rashed ed)*, op cit; pp 243-76; at p. 263. The Spanish translation in 1802 in two volumes was the work of Don Josef Antoine Banqueri. The French version was *Ibn Awwam Le Livre de l'agriculture*, by Clement-Mullet; in 3 vols, (Paris 1864-1867).
[1600] A. Mieli: *La Science Arabe*; op cit; p.213.
[1601] H. Bresc: Les Jardins de Palerme; op cit; p. 69.
[1602] Ibid.
[1603] In A Cherbonneau: *Kitab al-Filaha of Al-Ichbili,* op cit.
[1604] In A. Watson: *Agricultural Innovation,* Note 3; p. 190.
[1605] See: N. Deerr: *The History of Sugar*; op cit; pp. 67 ff; at pp. 80-1, in particular.

grown without resort to irrigation, but in the Islamic world it was heavily irrigated. Qustus al-Rumi says it requires continuous irrigation, and Ibn Luyun states that it needs weekly watering.[1607] According to Ibn Bassal, there are two systems of growing cotton in the Islamic world: the Spanish system, by which the plant is irrigated every fifteen days after it reaches a finger's height, and the Syrian system, by which the land is irrigated once before planting, again when the plant has reached the height of the palm of the hand, and thereafter every fifteen days until the middle of August.[1608]

Extracts from a description by Ibn al-Awwam of sugar cane planting is an excellent illustration of the meticulous attention to detail. It says:

> 'According to the book of Ibn Hajaj, the cane is planted from its roots on March 20th. As for the rest, it is necessary for it (according to the opinion common among the farmers in Spain) to have low, sunny land which has water near at hand. So it is planted from its own roots, and also from its own cane, having made the soil previously very mellow with three different spadings, or with ten plough shares, tooth cultivators (as others like), fertilising with a heavy layer of good, light decomposed manure (or with *Boniga* as others call it) and dividing into squares of 10 codos (1 codo is 18 inches) long and 5 codos wide. If the planting is made with roots, says Hajaj, the Granadan, having dug and made the corresponding holes in these squares, in them are planted cuttings at distances of a codo and half apart, and are covered with soil and manure to the thickness of three fingers; they are irrigated every fourth day and when grown to the height of a hand are cultivated well, and manured with a heavy layer of sheep dung and continued irrigation every eight days until the beginning of October, from which month irrigation is stopped. For the planting in which canes are used, one has to select the canes with the most joints and the thickest ones, because the first will give the most shoots and the second is more juicy. These canes freshly cut, or soon after, are placed completely in the earth, leaving them there till the beginning of March, from where they are taken out, then cut into pieces of two hands in length and of three joints (or according to some of six joints) each. These are trimmed with tools and are then planted in the above mentioned

[1606] V. Lagardere: La Riziculture en Al Andalus (VIIIem-Xvem siecles), in *Studia Islamica*, vol 83, (1996), pp 71-87.
[1607] In A. Watson: *Agricultural Innovation*, Note 3; p. 190.
[1608] Ibn Bassal: *Libro de agricultura*, Jose M.Millas Vallicrosa and Mohammed Azinan eds, (Tetuan Instituto Muley al-Hasan, 1953), pp. 152-3.

areas, covering four nodes of them at a distance of one codo apart, and sprinkling them afterwards with *Boniga,* which is carried out in the Autumn about September or about December, or some say, irrigate them continuously till they germinate.'[1609]

With regard to rice, we find an extremely vast literature, which Canard has proficiently outlined in an article in French, and which can now be found in an excellent English translation.[1610] Muslim authors such as Ibn Khurradadhbih (d. 912) inform us about the regions where rice is grown, its surface areas, the quantities produced, etc.[1611] We are also told how rice is grown. Rice is a summer crop, and depends much more than winter crops on irrigation being available.[1612] According to Ibn al-Awwam, however, rice may be sown twice a year.[1613] Muslim works give numerous details on how to choose the right soil to grow it in, on the right way of planting, thinning out, watering, and cutting and threshing it, on the right time of the year for planting, etc.[1614] Planting rice requires minute preparation: first the grains of rice had to be left to swell in a jar of water which had to stand in the sun during the day and to be covered with dung during the night, then the swollen grains of rice had to be sown into squares of land, sheltered by high walls and manured appropriately.[1615] These had to be watered in moderation, once every week. Thinning out the rice had to be done with particular care: the rice would be plucked before sunrise, then stored in a covered basket until evening, when it would be planted out. It then had to be watered until August.[1616] Diverse authors advise on matters relating to the crop. Ibn Bassal advises on the choice of soil, its preparation, the use of manure, and time for planting, whilst Al-Ichbilli dwells on the amount to be sown on any given surface, and the manner it ought to be done.[1617] Ibn al-Awwam focuses on irrigation, timing, and the amount of water needed at any given phase, as

[1609] Ibn al-Awwam: *Libro de agricultura*, ed. J. A. Banqueri (Madrid, 1802), in N. Deer: *The History;* op cit; p. 80.
[1610] M. Canard: Rice in the Middle East in the First Centuries of Islam; in *Production and the Exploitation of Resources*; edited by M. G. Morony (Ashgate; 2002), pp. 1-15.
[1611] Texts and translations: First edition with French translation and notes by C. Barbier de Meynard: le Livre des routes et des provinces; *Journal Asiatique*, vol 5, 1-127, 227-295, 446-532, 1865. A better text has been published by M.J. de Goeje, with French translation and notes: *Bibliotheca geographorum arabicorum*, 6 (Leyden; 1889), pp. 10-11.
[1612] M. Canard: Rice; op cit; p. 6.
[1613] Ibn al-Awwam: *Le Livre de l'agriculture*, by Clement-Mullet; 2 tomes in 3 vols (Paris 1864-1867), p. 59.
[1614] Ibn Basal: *Libro de agricultura*; op cit; p. 110-12; Ibn Wahshiyya: Filaha; op cit; p. 214-5.
[1615] M. Canard: Rice; op cit; p. 6.
[1616] Ibid.
[1617] In V. Lagardere: La Riziculture; op cit; pp 71-87.

well as its frequency. Field drainage, fighting pests, clearance of weeds etc, are elaborated upon; and so are harvest, storage and even culinary uses of the commodity.[1618] There is a great variety of rice recipes described by Muslim authors. Ibn Battuta, for instance, states that in the region of Mogadishu, in Somalia, a stew made from chicken, meat, fish and vegetables, which is also called Kushan, is poured over the rice.[1619] The best culinary stories and anecdotes on the subject are provided by the great al-Jahiz (ca. 776-868), in his *Kitab al-Bukhala* (Book of Misers).[1620] He describes, for instance, the way in which a miser treated his guests on his estate near Basra: he gave them rice bread and fish, which the guests themselves had to catch in the canal on the estate; another miser offered so little rice to his guests, that one such guest commented that if he had wanted to count the grains, that would have been easy as there were so few and separate; and in another instance, the rice was so badly cooked, or left uncooked, that the guests made a lot of noise chewing the grains.[1621] Remarkably, we find an account by the Muslim geographer, Yaqut al-Hamawi (d. 1229), stating that the heat and steam from the large number of ovens in which rice bread is baked in the province of Khuzistan (50,000), causes a rise in the temperature of the country, the first case of global warming, raised by a Muslim geographer in the early 13th century.[1622]

Central to the advance of farming was productive rotation of crops. Here, too, Islamic expertise developed centuries ahead of other regions, and was abundantly developed in literature. Where various rotations are given, Ibn Al-Awwam, for instance, explains that, contrary to ancient practice, wheat should not be grown in successive years on the same land but should be followed in rotation with barley and other crops.[1623] Bolens shows how Islamic farming insists on the importance of legumes, turnips, trimester wheat and cash crops.[1624] Among the sequences found by Bolens in the

[1618] Ibid.
[1619] Ibn Battuta: *Voyages d'Ibn Battuta*, Arabic text accompanied by French translation by C. Defremery and B.R. Sanguinetti, preface and notes by Vincent Monteil, I-IV (Paris, 1968), reprint of the 1854 edn' II; p. 82 and 185.
[1620] Al-Jahiz: *Kitab al-Bukhala* (Cairo ed H. 1323), p. 108.
[1621] Al-Jahiz: *Kitab al-Bukhala*; in M. Canard: Rice; op cit; pp. 9-10.
[1622] Yaqut, Ibn Abd Allah al-Hamawi: *Mu'jam al-Buldan; Jacut's Geographisches Worterbuch*, ed. F. Wustenfeld. 6 vols, (Leipzig, 1866-70), vol I; p. 413.
[1623] Ibn Al-Awwam: *Le Livre de l'Agriculture; op cit;* here from the Spanish translation of Don Josef Antoine Banqueri, vol 2; ii; pp. 11-15.
[1624] L. Bolens: *Les Methodes culturales au moyen age d'apres les traites d'agronomie andalous: traditions et techniques*, (Geneva, 1974), pp. 129-30.

manuscript of Abu al-Khair is the following: turnips, flax, broad beans, barley, wheat.[1625]

Muslim expertise also stretched to methods of fighting insect pests, use of fertilizers, grafting trees, crossing plants to produce new varieties, etc.[1626] On grafting alone, according to Scott, the Spanish Muslims employed eight distinct methods. Muslims, according to him, were also able to treat with success diseases of all known species of 'the vegetable kingdom;' and were exceedingly skilful in the distillation and refining of essences, and the cultivation of great plantations of flowers for the sake of the exquisite perfumes they afforded, and in preserving fruits for an indefinite period.[1627] Horticultural improvements, Sarton notes, constitute one of the finest legacies of Islam, and the gardens of Spain proclaim to this day one of the noblest virtues of the Muslims.[1628] Many indices, Bresc says, allow the formulation of the hypothesis that the technical legacy of the gardeners of the Palermo plains has been inherited from the Islamic period, and also brings closer Sicilian horticulture to that of Andalusia.[1629]

Crucial to farming life is the almanach, the first known to us being the famed 'Calendar of Cordova of 961.'[1630] Its Latin text was first published by Libri in 1838,[1631] whilst its Arabic text was edited by Dozy in 1873. Levi Provencal views the Calendar as the most precious of all treatises in the field, even if it is the oldest of the sort.[1632] Its technical accuracy is 'remarkable,' and much of what it contains was to be found in subsequent geography books and farming treatises. It highlights the role of each month of the year, March, for instance, the month for fig tree grafting, and early cereal planting. It is also the month for planting sugar cane and sowing cotton and saffron. March is when pre-season roses and lilacs come out; when quails make their appearance; silk worms hatch; and mullets journey up rivers from the sea. During this month mail orders for the purchase of horses for the government are sent to provincial officials; and also locusts first appear and their destruction is ordered. It is the time

[1625] Ibid.
[1626] F.B. Artz: *The Mind;* op cit; P.150.
[1627] S.P. Scott: *History;* op cit; vol 2; pp. 605-6.
[1628] G Sarton: *Introduction*, op cit; Vol II, p .56.
[1629] H. Bresc: Les Jardins de Palerme; op cit; p.67.
[1630] Details of which in E.L. Provencal: *History*, op cit, pp. 289-90.
[1631] Libri: *Histoire des sciences mathematiques en Italie* (Paris, 1838), I, p. 393 and foll.
[1632] E. Levi Provencal: *Histoire;* op cit; p.239

to plant lime and marjoram, too. It is also the mating season of many birds.[1633]

Going back to the matter of impact, this calendar also has Yemeni origin, confirming patterns observed above on the Yemeni pioneering role in farming. The Yemen, indeed, had an established calendar in use for agricultural and activities as reported by al-Hamdani, about 900.[1634]

There is also an interesting calendar by al-Makrisi (Al-Makrizi), which notes under the month of November, for instance:

> 'On the 7th of this month cutting of the cane for the presses begins... after the old and sickly animals have been sold and others more vigorous have been bought, as well as reeds and straw for the boiling house. The workpeople are employed in the manufacture of abloudjats, funnels and the vases destined for the sugar and molasses.'[1635]

For December, he writes:

> 'Cane crushing begins and sugar boilers are engaged. Lands are planted with cane and colocasia. Dykes are opened at the end of this month. The best cane is crushed after having reserved enough for seed. The construction of sakiats (irrigating machines) is pushed on.'[1636]

Muslim authors devoted vast interest to the study of plants, their composition, structure, and also their uses for medicinal purposes. Al-Dinawari (d. 895) deals with a wide variety of plants, and describes their transformations and changes during their growth. From his predecessors, he derives knowledge on aromatic plants, plants used in dyes and for other purposes.[1637] He also devotes one chapter to the classification of plants (*tajnis al-nabat*).[1638] Ibn Wahshiya's *Filaha Nabatiyya* (Nabatean Agriculture),[1639] one of the earliest of the sort, makes a comprehensive classification of plants.[1640] Another early work on the subject is the anonymous *Umdat al-tabib fi ma'rifat al-nabat li-kull labib*, which was a pioneering attempt at the classification of plants by genus (*jinse*), species

[1633] Ibid; pp.289-90.
[1634] R. B. Serjeant: Agriculture and Horticulture; op cit; p. 538.
[1635] Al-Makrisi: *Description topographique et historique de l'Egypte*; Trans Bouriant and Casanova (Paris; 1895 and 1906); pp. 57 and seq.
[1636] Ibid.
[1637] T. Fahd: Botany, op cit, pp 813-52.
[1638] B. Lewin: The Third part of *Kitab al-Nabat* of Abu Hanifa al-Dinawari,' *Orientalia Suecena* 9, (1960), pp: 131-6.
[1639] Ibn Wahshiya (903-4): *Al-Filaha al-nabatiyya*". Agr.Ms. 490 (Dar al-Kutub, Cairo).
[1640] *L'Agriculture Nabateene*. Translation into Arabic attributed to al-Kasdani, known as Ibn Wahshiya. Critical edition by T. Fahd, 2 Vols (Damascus, 1993 and 1995).

(*naw*) and variety (*sanf*).[1641] Ibn Baja (d. 1138,) in *Kitab al-nabat (liber de Plantis*) also deals with the physiology of plants, whilst emphasising their infinite variety. Ibn Wafid *Majmu' fi'l Filaha* (Compendium of Farming) focuses on the naming and uses of many of the new plants being introduced into Spain. The geographer Ibn Battuta (d.1377), as he recounts his travels, offers extremely detailed descriptions of plants, fruit and vegetation of India, Java, the Maldives, etc.[1642] He includes the common: apricots, quince, grapes, watermelons, sweet oranges etc, but also the exotic: coconuts, mango trees, cinnamon, Brazil nut, benzoin, camphor and clove amongst others.[1643]

Experimental gardens were the privileged setting for adapting and studying plants. It was in Muslim Spain in the 11th Century, that the first royal botanical gardens of Europe made their appearance, five centuries ahead of similar ones in Western Christendom.[1644] These were both pleasure gardens and also trial grounds for the acclimatization of plants brought from the Near and Middle East.[1645] Royal and experimental botanical gardens were often in the charge of leading scientists. In Spain, agronomists had at their disposal botanical gardens and trial grounds where they experimented with exotic plants, and tried to create new varieties of fruit and flowers.[1646] The literature around this subject, Armesto notes, is prolific. A veritable school of court gardeners flourished, unparalleled elsewhere in the medieval West.[1647] They knew each other and read each other's works, and dealt with practical agriculture.[1648] Their common background was in royal patronage, their common formation in the lush experimental gardens of powerful sybarites in Toledo and Seville, where they were employed on every project that might enhance luxury, from concocting compost to inventing recipes for foie gras.[1649] They were learned men and keen, practical gardeners, too.[1650] Hence, Al-Tignari, the author of a farming manual, made botanical gardens for a Spanish Taifa king and then for the Almoravid prince Tamim.[1651] In

[1641] J. Vernet and J. Samso: Development, op cit, p. 262.
[1642] Ibn Battuta: *Voyages d'Ibn Batoutah*, op cit.
[1643] Ibid.
[1644] G.S. Colin: Filaha; *Encyclopaedia of Islam*: New edition (Leiden; 1986), Vol 2, p. 902.
[1645] Ibid.
[1646] Ibid.
[1647] F.F Armesto: *Millennium*; op cit; p.35.
[1648] Ibid; p.36.
[1649] Ibid; p.37.
[1650] Ibid.
[1651] J.M. Millas Vallicrosa: Un Nuevo manuscrito de la obra agronomica al Tignari; *Tamuda*; 1; (1953); pp. 85-6.

the garden of a sultan of Seville, the anonymous author of a botanical treatise domesticated rare plants and acclimatized exotic ones.[1652] In the 12th century the botanist and physician al-Shafran collected plants from many outlying regions of Spain for the garden of an Almohad sultan at Guadix.[1653] The Huerta del Rey in Toledo was directed by two of Spain's leading agronomists: Ibn Bassal and Ibn Wafid, both of whom carried out agricultural experiments and wrote important manuals of farming. Ibn Bassal eventually fled from Toledo in 1085, when it was captured by Alfonso VI of Castile, for Seville, to the court of Al-Mutamid for whom he created a new royal garden.[1654]

The gardens of the medieval Islamic world, and particularly the royal gardens, were, according to Watson, places where business was mixed with pleasure and science with art.[1655] These gardens linked together the agricultural and botanical activities of distant regions, and played one of greatest roles in the diffusion of useful plants.[1656] Only many centuries later did Europe possess similar botanical gardens which helped to make it the same kind of medium for plant diffusion that the Islamic world had been in the middle ages.[1657] The earliest botanical gardens in Europe appear to have been planted by Matthaeus Sylvaticus in Salerno (c.1310) and by Gualterius in Venice (c.1330), but only in the 16th and 17th centuries did other European cities and universities follow suit: Pisa: in 1543; Padua, Parma and Florence in 1545; Bologna in 1568; Leyden in 1577; Leipzig in 1580; Konigsberg in 1581; Paris (le Jardin Royal du Louvre) in 1590; Oxford in 1621 etc.[1658]

5. Introduction and Diffusion of New Crops:

Central to the (Islamic) agricultural revolution, Watson writes, was the introduction of many new crops into the early Islamic world and their

[1652] Asin Palacios: *Un Botanico arabigoandaluzdesconocido* (Madrid; 1942), p.9.
[1653] L. Leclerc: *Histoire de la Medecine Arabe* (Paris; 1876), vol 2; p. 250.
[1654] G.S. Colin: Filaha; *Encyclopaedia of Islam*: Vol 2, op cit; p. 901:
[1655] A. Watson: *Agricultural Innovation*, op cit, p. 119.
[1656] Ibid.
[1657] Ibid.
[1658] See: A. Chiarugi: Le date di fondazione dei primi orti botanici del mondo,' *Nuovo giornale botanico italiano* new ser. LX (1953) 785-839; A.W. Hill: The History and function of botanical gardens; *Annals of the Missouri Botanical Garden;* II (1915) 185-240; 195 fwd; F. Philippi: *Los jardines botanicos,* (Santiago de Chile; 1878), etc.

widespread diffusion, crops which include rice, hard wheat, sugar cane, cotton, artichokes, lemons, etc.[1659] In addition to these, many other useful plants were diffused in the same period: food and fiber crops or plants grown as sources of fodder, spices, condiments, medicines, cosmetics, perfumes, garden flowers, ornamental plants, and, also, many new strains of old and new plants were developed and diffused.[1660] In his larger work devoted to the subject, Watson devotes most chapters to such crops, and describes at great length the process of collecting plants, their growth in different environments, and their general diffusion between places.[1661] He focuses on the principal crops that were diffused by the Muslims: Sorghum, Asiatic rice, hard wheat, sugar cane, cotton, sour orange, lemon, lime, shaddock, banana, plantain, coconut palm, watermelon, spinach, artichoke, colocasia, eggplant, and mango tree.[1662] Watson explains the patterns of diffusion, the diversity in the agents of diffusion, the facilitating elements, which include institutional, social and economic factors, and also, the experimentalist nature of the Muslims, as well as the impact such plant diffusion had on the local economies.[1663]

The diffusion of sugar cane had a decisive impact on farming, society, and, above all, on industry. Its impact on the latter has been looked at in the first part; its role on Islamic farming is briefly outlined here.[1664] Muslim geographers describe its cultivation and use in great abundance. An account by al-Istakhri (c. 950) runs:

> 'I have travelled on the river Masukran from Asker-Mokkaram by way of Ahwaz… of its water not a drop is lost, and it is all used for watering palm groves, grain and sugar fields… In all this great area there is no place in which sugar cane does not grow, and this is brought to Asker Mokarram for manufacture. The cane of this town itself is also that of Tuster and Sus, and does not contain much sugar; it is eaten direct and is not crushed. But all the cane of Masukran is brought to Asker-Mokarram, and all the people get their living out of sugar cane. It is partly used as food and partly made into sugar.'[1665]

[1659] A.M. Watson: A Medieval Green Revolution: op cit; p. 220.
[1660] Ibid.
[1661] A.M. Watson: *Agricultural Innovation*; down to chapter 20.
[1662] Ibid.
[1663] Ibid.
[1664] Remarkably, one of the best outlines on the Islamic sugar industry is found in the little known work by N. Deerr: *The History of Sugar*; 2 vols (Chapman and Hall Ltd; London; 1949), vol 1; esp . pp. 68 ff.
[1665] Al-Istakhri: *Book of Lands*; trans Mordtmann (Hamburg; 1847), p. 57.

In the Holy land, the cane was grown at Nablus, around the Lake of Tiberias, and especially in the Jordan valley, including Jericho at the head, and the district of Kerak, at the extreme south east of the Dead Sea, in all these places irrigation from streams and rivers being available.[1666] The Syrian industry is of great interest as it was here that the Crusaders first saw it and became acquainted with this sweet substance other than honey.[1667] Fulcherius Carnotensis, thus, says:

> 'On the fields of Laodicea we found certain reed-like plants called *Cannamella*, because from them is obtained, as I believe, an elaborate manner *mel silvestre*. On accounts of its sweet juice we chewed it against thirst.'[1668]

In Egypt, Al-Idrisi, about the year 1150, pictures the whole area around Cairo as one well watered cane field, and mentions Caus, Miniet, Chamain, Terfet and Sennista in the Fayyum (the district south of Cairo and extending about 200 miles upstream) as centres, as well as the oasis in lower Egypt, about 100 miles further south.[1669]

As the industry spread westward, it had the same impact in Morocco, Spain, and Sicily.[1670] In Muslim Spain, especially in the provinces of Grenada and Malaga were numerous fields and sheltered valleys watered by streams rising in the Sierra Nevada, which afforded opportunity for irrigation, and in places such as Motril, as late as 1930 could be found an industry not far remote in its condition from that practiced by the Muslims.[1671]

Cotton played a central role, wherever it was introduced due to its vast impact on both farming and industry. Some of the best writing on this subject is by Lombard who explains how cotton was planted, transported between places, and used in manufacturing.[1672] Syria, once more, took a leading place in the cropping and manufacture of the crop. Following the arrival of Islam in that country, cotton from Higher Mesopotamia was acclimatised there, and Syria, soon, became the medieval largest cotton producer of the whole Mediterranean world.[1673] Syrian cotton fields filled Western Christian pilgrims with amazement.[1674] During the crusades, the

[1666] N. Deerr: *The History of Sugar*; op cit; p. 74.
[1667] Ibid.
[1668] *Gesta dei Francos;* ed. Bongars (Hanoviae; 1611), I; p. 401.
[1669] Al-Idrisi: *Geography;* Trans Jaubert (Paris; 1836), I; pp. 123-4; 128 etc.
[1670] M. Lombard: *The Golden Age;* op cit; p. 167.
[1671] N. Deerr: *The History of Sugar*; op cit; p. 80.
[1672] M. Lombard: *Les Textiles*; op cit.
[1673] Ibid; p. 68.
[1674] Ibid.

crusaders in the Antioch region grew it in quantity, and by 1140, Genoese merchants imported considerable quantities of the stuff.[1675] From Syria, cotton reached Cyprus, where it was planted on the island's Central Plains, and also reached Mesorea, as well as Crete.[1676] Cotton also thrived in North Africa. It was grown under irrigation on the northern parts of the Sahara, and also around Carthage and Tunis from where it was carried to the manufacturing centres of Al-Qayrawan.[1677] Cotton was also abundantly grown in Morocco, especially around Fes and Tangiers, and it supplied the many workshops, which in turn manufactured clothing items that were much in demand in the export trade.[1678] It is from North Africa that cotton was introduced into both Spain and Sicily, its first mention in Spain dating from 961 in the Calendar of Cordova.[1679] Ibn al-Awwam offers plentiful information on the manners, time, and places it was grown,[1680] and Andalusian poetry, likewise, includes many allusions to cotton, its whiteness a metaphor for jasmine blossoms and snow.[1681]

Rice, although known in many pre-Islamic places, was diffused into such parts more widely in the early Islamic era, and also in places where it was not known, and then into Europe. Iraq produced vast quantities of rice in the region watered by the Euphrates and the River Sura, and in Batiba, in the Jamida region, downstream from Wasit and west of the Tigris.[1682] Cultivation of rice is also reported in the region of Baysan in Palestine, the region of Tarsus in Cilicia, and also in Egypt, in the Fayyum and Sa'id (Upper Egypt).[1683] It was so intensively grown in the Fayyum, that it became a large export centre of the commodity. Rice was also cropped further to the East, in Khuzistan, and in Khurasan, and in the lowlands south of the Caspian Sea.[1684]

It was the Muslims who introduced a great variety of crops and farm products into Muslim Europe, which were eventually transferred to the Christian West. Wickens notes how the West's borrowings from the

[1675] E.G. Rey: *Les Colonies Franques*; op cit; pp. 190; and 249.
[1676] Gilles Le Bouvier dit Berry: *Le Livre de la Description des Pays* (Paris; 1808), pp. 65; 69.
[1677] Ibn Hawqal; Idrisi; in M. Lombard: *Les Textiles*; op cit; p. 74.
[1678] M. Lombard: *Les Textiles;* op cit; pp. 74-5.
[1679] Ibid; pp. 77.
[1680] Ibn Al-Awwam: *Le Livre*; Clement Mullet Tr. II; I; pp. 101-3.
[1681] H. Peres: *La Poesie Andalouse en Arabe Classique au XI em Siecle* (Paris; 1937), pp. 180 and 230.
[1682] Accounts by Muslim geographers outlined in M. Canard: Rice; op cit; pp. 2-3.
[1683] Ibid; pp. 4-5.
[1684] Ibid.

Middle East form practically the whole basic fabric of civilisation, including agriculture; the domestication of animals for food; drainage and irrigation; plants and crops etc.[1685] From the Muslims, Spain, for instance, received (apart from a legendary high culture), and she in turn transmitted to most of Europe, all manner of agricultural and fruit-growing processes, together with a vast number of new plants, fruits and vegetables that we all now take for granted.[1686] Amongst these were sugar cane, rice, citrus fruit, apricots, cotton, artichokes, aubergines, etc.[1687] Carra de Vaux, for his part, notes the large variety of flowers, plants and animals that came from the Orient, and are used in agriculture, pharmacy, gardens, luxury trade, and arts.[1688] He lists tulips (from Turkish: tulpan,), hyacinths, narcissi from Constantinople, Lilacs, jasmine from Arabia, roses from Shiraz and Ispahan, peaches from Persia, the prunes from Damascus (brought in by the Crusaders), figs from Smyrna, silk, cotton, and also plants and products used for dyeing.[1689] De Vaux also dwells on animal species, focusing his interest on 'one of the great glories' from the Arab world: the pure blood Arab horse, highlighting the Arab affection and expertise in breeding and caring for their horses,[1690] and their writings on the subject, notably the treatise by Abu Yusuf *Kitab al-furusiyeh*, and a veterinary treatise by Abu Bakr, which was later translated into French by Perron.[1691]

Most plants were diffused from the Muslim world into the Christian West in the high medieval period. Shallots derive their name from Ascalon (Cepa Ascalonia), and were imported during the crusades (1095-1291).[1692] Spinach was imported first to Spain, where it was largely witnessed in the 11th century, from where it was diffused to the rest of Europe.[1693] It was

[1685] G. M. Wickens: 'What the West borrowed from the Middle East,' in *Introduction to Islamic Civilisation*, edited by R.M. Savory (Cambridge University Press, 1976), pp 120-5. at p. 120.
[1686] Ibid; p. 125.
[1687] W.M. Watt: *The Influence;* op cit; pp. 22-3. A. Pacey: *Technology in World Civilization, a Thousand Year History* (The MIT Press, Cambridge, Massachusetts, 1990), p. 15.
[1688] Baron Carra de Vaux: *Les Penseurs de l'Islam*, vol 2; op cit p. 306.
[1689] Ibid; pp. 309-19.
[1690] Ibid; pp. 329-36.
[1691] *Le Naceri: Traite complet d'hippologie et d'hippiatrie* (Paris, 1852-1860), 3 vol.
[1692] J. Andre: *l'Alimentation et la cuisine a Rome* (Paris; 1961), p. 20.
[1693] M. Rodinson: Les Influences de la Civilisation Musulmane sur la Civilisation Europeene Medievale dans le Domaine de la Consommation et de la Distraction: l'Alimentation; in *Convegno Internationale: Oriente e Occidente Nel Medioevo Filosofia E Scienze;* 9-15 Aprile 1969 (Academia Nationale Dei Lincei; Roma; 1971), pp. 479-99. p.484.

one of the earliest such crops to be received into Europe, but it did not appear until the 13th century when it seems to have made rapid progress.[1694] Aubergines, which spread into Italy in the 14th century, came from Muslim Spain.[1695] Sorghum, too, is mentioned in Italy by the late 12th and 13th centuries, by which time it had arrived in the south of France.[1696] Durum wheat probably appeared in the 13th century.[1697] Rice was not entirely unknown to the Europeans, but it was the Muslims who grew it on irrigated fields in Sicily and Spain, whence it came to the Pisan plain (1468) and Lombardy (1475).[1698] Other crops which the Muslims either introduced or intensified considerably include the mulberry tree and saffron: the first was necessary for silk worm husbandry and industry; the second, appreciated in cooking, and also in the medical sciences.[1699] Sour oranges and lemons appear to have spread slowly through parts of Italy and Spain in the 13th and 14th centuries.[1700] Sub-tropical crops such as bananas and sugar cane were grown on the coastal parts of Spain in the Muslim period,[1701] but subsequently were taken to the Spanish colonies in the Americas.

The Islamic diffusion of plants was not just geographical but also qualitative, through the crossing of plants. Al-Jahiz stated that in the 9th century, 360 kinds of dates were to be found in the market of Basra, while in the following century, Ibn Wahshiya wrote that the varieties of dates in Iraq could not be counted. According to Ibn Rusta, who wrote in the early 10th century, there were 78 kinds of grapes in the vicinity of Sanaa (Yemen).[1702] The Baghdad based scholar Abd al-Latif (13th century) refers to species crossed between each other leading to an infinity of varieties.[1703] Al-Ansari writing after 1422 in Ceuta (Morocco) talks of local orchards producing 15 varieties of apples, 17 varieties of apricots, 28

[1694] Crescentiis bk vi 55; 103 in A. Watson: *Agricultural*; op cit; pp. 81-3.
[1695] D. Bois: Les Plantes alimentaires chez tous les peoples et a travers les ages; vol1; Paris; p. 355.
[1696] Crescentiis book iii 7; V.Niccoli: Saggio storico; Turin; 1902; p. 189; J.J Hemardinquer: l'Introduction du Mais; 1963; pp. 450-1 in A.M. Watson: *Agricultural*; op cit; p. 81-83
[1697] G. Alessio: Storia linguistica; 1958-9; pp. 263-5; M. Gual Camarena: Vocabulario del commercio medieval; Tarragona; 1968; p. 422; in Watson: *Agricultural*, pp 81-3.
[1698] R.J. Forbes: *Studies*, op cit, p. 49.
[1699] P. Guichard: Mise en Valeur; op cit; p. 178.
[1700] G. Alessio: Storia linguistica; in A.M. Watson: *Agricultural*; op cit; pp 81-3.
[1701] E. Levi Provencal: *Histoire*, op cit, p.283.
[1702] In A.M. Watson: *Agricultural*; op cit; p. 1.
[1703] P. Guichard: Mise en Valeur; op cit; p. 178-9.

of figs, 14 of prunes, 36 of pears, 9 of walnuts, and 65 of grapes.[1704] What seems certain, Watson notes, is that the range of useful plants available to the cultivator-and to the consumer-was greatly increased in the early centuries of Islam by the diffusion of new plants and the development of new cultivars.[1705]

Behind the diffusion of plants certainly lay the attraction of profit; however what also stimulated such diffusion was, according to Watson, the large and unified region, which for three or four centuries, and in places still longer, was equally receptive to all that was new, and was able to diffuse novelties, 'both to effect the initial transfer which introduced an element into a region and to carry out the secondary diffusion which changed rarities into commonplaces.'[1706] Even when the so-called Muslim empire was politically broken (Abbasids in the East, Umayyad in Spain, etc), there was still a great cultural, social and economic unity within the disparate lands such as Spain, the Yemen, and Central Asia. These regions, although equally very much disparate in terms of climate, soil, water resources etc, did not prevent Muslim farm experimentalists from devising ways whereby crops from one region adapt to another.
In this instance, we find the very factors that centuries later stimulated the expansion of agriculture, trade and industry in the West, used in the same way in the Islamic setting. Many of the new crops, first, came to be known in the Islamic world as luxury imports, at the outset as medicines for the rich, and later as food-stuffs served on the tables of rulers and their courts.[1707] Demand for these products widened, and as wealthy people in the capital and great provincial cities imitated the eating habits of those rulers and their courts, and were themselves imitated by those further down the social ladder, eventually a critical point was reached whereby domestic production replaced imports.[1708] And as skills were acquired, costs were cut, demand rose further, leading to further innovations and greater supply. As the Islamic world split into various centres of power, this had the impact of scattering tastes concentrated in one place over a wider geographical area.[1709]
Also playing their part in such diffusion were good infrastructure, the booming scientific climate, state institutions, and thriving economic

[1704] Ibid; p. 179.
[1705] A.M. Watson: *Agricultural*; op cit; p. 1.
[1706] Ibid; p.2.
[1707] A.M. Watson: A Medieval Green Revolution; op cit; p. 46.
[1708] Ibid.
[1709] Ibid.

foundations, all contributing to this capacity to absorb and to transmit.[1710] Equally important was the personal interest or passion that drove rulers and ordinary individuals to seek to adapt new species. Hence, Abd Errahman I, out of nostalgia for the Syrian landscape, was personally responsible for the introduction into Spain of several species, including the date palm.[1711] A pomegranate variety was introduced from Damascus by the chief judge of Cordoba, and a Jordanian soldier named Safar took a fig cutting and planted it on his estate in the Malaga region. This species, called *safri* after the soldier, subsequently became widely diffused.[1712] Crossing species to produce new ones certainly responded to the spirit of experiment that was very much current in the Islamic world, at that time a spirit common to the astronomer, the chemist, and the farmer.

The new crops impacted considerably on the local economies and societies of many places. In West Africa, for instance, villages became larger and more numerous as new crops, introduced in Islamic times, made the soil much more productive than it had been.[1713] In Spain and Sicily, under Muslim influence, a silk industry flourished, flax was cultivated and linen exported, and esparto grass, which grew wild in the more arid parts, was collected and turned into various types of articles.[1714] Glick notes how the introduction of new crops combined with intensification of irrigation, gave rise to a complex and varied agricultural system, whereby a greater variety of soil types were put to efficient use.[1715] In Spain, wherever artificial irrigation was possible, in the Andalusian Vegas, the Huertas of Murcie and Valencia, all crops, including tropical plants, flourished, and brought in huge economic benefits.[1716] The same happened in Sicily, where it is must be remembered, practically all distinguishing features of its husbandry were introduced by the Muslims: citrus, cotton, carob, mulberry, sugar cane, hemp, date palm, saffron....[1717] Many constitute the foundations of the economy today.[1718] Even plants such as papyrus, which although it may have been introduced by the

[1710] A.M. Watson: *Agricultural*; op cit; p. 2.
[1711] T. Glick: *Islamic*, op cit, p. 76.
[1712] Ibid.
[1713] See A. Chevalier: Le Role joue par les migrations humaines dans la repartition actuelle de quelques vegetaux; *Congres de l'Association Francaise pour l'Avancement des Sciences* (Liege; 1925), pp. 990-6.
[1714] W.M. Watt: *The Influence*, op cit, pp 22-3.
[1715] T. Glick: *Islamic*; op cit; p.68 fwd.
[1716] E. Levi Provencal: *Histoire;* op cit; p.265.
[1717] A. Lowe: *The Barrier and the Bridge* (G. Bles, London, 1972), p. 78.
[1718] F. Gabrieli: "Islam in the Mediterranean World", in *The Legacy of Islam*, ed by J. Schacht-C.E. Bosworth, 2nd edition (Oxford Clarendon Press, 1974), pp. 63-104, at p. 75.

daughter of Ptolemy, was first used by the Muslims as a writing material.[1719] This Islamic impact is highlighted by the fact that the plants grown in Sicily are well elaborated upon in Muslim farming manuals; a rich variety which contrasts with the dearth of crops from northern European farms.[1720]

The impact of such new crops on activities other than agriculture was equally dramatic. The introduction of new crops first led to sharp rises in employment, most often outside agriculture, and the workers who carried out diverse tasks related to the exploitation and manufacture of such new crops at diverse stages, sold both their products and labour on the market.[1721] Other tasks required such a degree of skill or such expensive equipment that they were often carried out by a specialised labour force.[1722] Forbes insists on the role of the new crops and the new methods and machinery the Muslims introduced. These new crops would not have been grown with the typically classical agricultural methods.[1723] The new crops brought into existence new industries and techniques, as seen in Part One in relation to cotton and sugar. Rice, too, could be milled by hand operated querns in the home but also, and most often, the task was accomplished by mills powered by animals, water or wind.[1724] The new crops also impacted considerably on trade, both local and foreign. Cotton, (and cotton thread and cloth), rice, sugar, coconuts (as well as the fronds, branches, and trunks of the coconut palm), and doubtless other new crops were traded over long distances in the Islamic world.[1725] Some were exported on a large scale beyond the Islamic world, sugar and cotton, for instance, were sent to many parts of Christian Europe.[1726] This trade generated an important class of intermediaries trading in foodstuffs, and these merchants, in turn, were serviced by transporters, financiers, and warehouse owners.[1727]

[1719] A. Lowe: *The Barrier;* op cit; p.79.
[1720] H. Bresc: Les Jardins de Palerme; op cit; p. 71.
[1721] A.M. Watson: A Medieval Green Revolution; op cit; p. 47.
[1722] Ibid.
[1723] R.J. Forbes: *Studies,* op cit, p. 49.
[1724] H. Lautensach: *Maurische Zuge im geographischen Bild der Iberischen halbinsel* (Bonn; 1960), p.81.
P.Casanova: Essai de la Reconstitution de la ville d'Al Foustat ou Misr; *Memoire de l'Institut Francais d'Archaeology Orientale*; 35 (1919), p. 155.
[1725] A.M. Watson: A Medieval Green Revolution; op cit; p. 48.
[1726] See W. Heyd: *Histoire*; op cit; vol 2; pp. 611 ff;
F. Balducci Pegolotti: *La Pratica della mercatura;* ed. A. Evans (Cambridge; Mass. 1936).
[1727] A.M. Watson: A Medieval Green Revolution; op cit; p. 48.

6. Background for Change:

The background to the Islamic agricultural revolution was very favourable, summed up by Watson as consisting of:

> 'Rulers who imported plants for their botanical gardens; their advisers, who urged the importance of a prosperous countryside; jurists, who interpreted legal traditions so as to accommodate the needs of an expanding agricultural sector; botanists, who herborised the length and breadth of the Islamic world; agronomists, who produced a wealth of farming manuals; geographers, who wrote enthusiastically about the agriculture of the regions they visited; peasants and landowners who experimented with new crops; and many other urban and rural dwellers-mostly now lost from view-who showed on their tables their love for exotic foods and told of their love of greenery in their poems and in their gardens.'[1728]

A crucial factor that stimulated not just the Islamic agricultural revolution, but the whole Islamic civilisation was its open, frontier-less, mobile world, which encouraged movement of people for a variety of purposes. Early Islam was, indeed, marked by a great urge to travel, whether to study Islamic tradition, especially from a reputed scholar, or for trade, or pilgrimage.[1729] This stimulated considerably every single science, and agriculture, just as its parent science, botany, was in the process vastly advanced by such movements.[1730] Hence, in the process of the vast amount of travel by all classes of people back and forth across the land of Islam, easterners took with them to the west, and westerns took with them to the east, the habits of their homelands, and acquired new ideas, tastes, and objects.[1731] Amongst such travellers were peasants and farmers, to whom must be added traders, scholars, and also envoys sent by rulers who sought to enrich their gardens, all such travels accounting for the movement of crops, irrigation technology, and farming techniques, which were carried principally from east to west.[1732] Many instances of individuals playing this role of diffusers have been seen under the previous heading.

[1728] A.M. Watson: *Agricultural*; op cit; p. 6.
[1729] R. Bulliet: Travel and Transport; *Dictionary of the Middle Ages*; op cit; vol 12; pp. 147-8.
[1730] See, for instance, L Leclerc: *Histoire de la Medecine Arabe*; 2 vols (Paris; 1876).
[1731] A.M. Watson: A Medieval Green Revolution; op cit; p. 37.
[1732] Ibid.

Tax laws, inspired by the Qura'nic text and Islamic jurisprudence affected different types of land and multiple kinds of crops, and compared to pre-Islamic times, or later times, these taxes were relatively low.[1733] They thus provided strong incentives for land rehabilitation and improved use. One law provides that land watered by buckets (or in later extensions of this principle, land that was watered by water wheels or any other kind of lifting device) should pay only one-twentieth of its produce in tax instead of the normal tenth or any higher rate that might have applied.[1734] This provision surely must have given a strong incentive to introduce the water-lifting devices which became so common in the Islamic world, and which were crucial both in prolonging the irrigation season after the annual flooding of a river and in bringing water to lands that could not be reached at all by gravity flow.[1735] Another law exempted, or taxed at only half the normal rate, lands planted with permanent crops that had not yet begun to yield, which no doubt encouraged investment in tree crops, such as bananas, citrus, mangos and coconut palms, which ultimately yielded far higher returns than the traditional crops.[1736] An even more crucial Islamic law was the ruling by the Prophet that the person who brought into cultivation land that had been "dead" or uncultivated for more than three years should gain outright ownership of this land; moreover, such land, when it began to produce, was to be taxed only at one tenth of its produce and no higher which was otherwise allowable.[1737] Revivification of lands confers ownership. Canals dug to bring water to dead lands belonged to those who dug them, and wells and qanats made in dead lands in order to revive them also belonged to those who made them.[1738] This law may therefore have been a powerful force favouring the expansion of sedentary agriculture over grazing, and pushing back the frontiers of settlement into the desert.[1739] Under such a system of low taxes, landowners and tenants alike were secure in the knowledge that they, instead of the state, benefited most from their hard work, innovations and improvements to the land.[1740]

[1733] A. M. Watson: *Agricultural;* op cit; p. 29.
[1734] Ibid; p. 28.
[1735] Ibid.
[1736] Ibid.
[1737] See A. Ben Shemesh: *Taxation in Islam* (Leiden; 1958-69), I; 65-6; ii; 31-3; etc..
[1738] Al-Mawardi: p. 389; ff; in A.K.S. Lambton: ma'; op cit; p. 871.
[1739] A. Watson: *Agricultural;* op cit; p. 29.
[1740] Extracts from Ibn Khaldun's Muqqadima on his passage on the cause which increases or reduces the revenues of empire, in *Bulletin d'Etudes Arabes*, Vol 7, pp 11-15, De Slane's edition, vol II, pp 91-4.

The Islamic legal corpus, once more, brought changes that removed many obstacles to land exploitation. Favourable institutional conditions, which prevailed in Islam, also freed the countryside from many arrangements that were economically retrograde.[1741] Under Muslim rule, the condition of the serfs was greatly improved, whilst tribute was regulated by law, and ceased to depend upon capricious demands.[1742] Lowe observes how, for Sicily, Muslim rule was an improvement over that of Byzantium.[1743] The latifondi were divided among freed serfs and small holders, and agriculture received the greatest impetus. Thanks to Muslim law, uncultivated land became the property of whoever first broke it, thus encouraging cultivation at the expense of grazing.[1744] Pre-Islamic taxes, for instance, stood in the way of innovations, and favoured both large estates and the serfdom of the peasantry.[1745] Low Islamic rates of taxation helped stimulate the cultivation of the land and its improvement, and kept alive a class of smaller, independent landowners and a relatively prosperous peasantry.[1746] Imamuddin quotes from the documents of the School of Arabic Studies in Madrid the type of contract entered into by cultivators and landlords for the bringing of waste land (what would in Arabic be called *mawat*) under cultivation.[1747] He also cites examples of share cropping contracts (one would call these *muzara'ah, musaqah,* etc. in Arabic) that bear close resemblance to examples given in the standard Muslim law-books, and such forms of contract as those studied by Serjeant, and which are also applicable today.[1748]

Early Islamic rulers, as a whole, were equally passionate about plants, gardens, water and greenery, and such passions played a major part in the rise of Islamic agriculture. An early promoter of Islamic farming was the Umayyad ruler, Abd Errahman I (r. 755-788), who, as soon as he took control in Spain, sent an expedition to Levant to collect material for his garden in Cordova.[1749] The Banu Di Nun ruler, Al-Mamun of Toledo (r. 1043-1073), had the magnificent and beautifully named *Bustan al-Na'ura* (The Garden of the Noria) erected, in which was constructed *Qubbat al-*

[1741] A. Watson: *Agricultural;* op cit; p. 115.
[1742] S.P. Scott: *History*; op cit; Vol 1; p.259.
[1743] A. Lowe: *The Barrier*; op cit; p. 78.
[1744] Ibid.
[1745] See last part of this work on the impact on farming following the Christian re-conquest in the East, Spain and Sicily.
[1746] A. Watson: *Agricultural*; op cit; p. 115.
[1747] In R. B. Serjeant: Agriculture and Horticulture; op cit; p. 541.
[1748] Ibid.
[1749] Al-Maqari: *History*; op cit; p. 86.

Naim (The Pleasure Dome), which fill the lines of poets.[1750] Other rulers with a similar passion for gardens and greenery dominated the early centuries of Islamic rule, from the Aghlabid rulers of Tunisia, to the Tulunids of Egypt, the Almoravids of Morocco.[1751] On top of their passion for greenery, early Muslim rulers also understood the economic function of the sector, as expressed here in the lines of one such early ruler, Caliph Mu'tasim (r. 833-42):

> 'Agriculture has many merits. It enriches the earth and nourishes the human race. It permits the collection of the *kharaj* (tax) and develops the public wealth. It feeds domestic animals, lowers the price of foodstuffs, increases the sources of commerce, and contributes to well being.'[1752]

Such rulers worked towards stimulating and promoting the growth of the sector, state intervention that acted positively on a variety of levels. In Egypt, for instance, Guichard explains, the state was behind complex systems of land classification, crop and harvest planning, grading the volume of water available after the floods of the Nile, allocating seeds and plants for the peasants, who were given the facility to pay for them after their harvest, and so on.[1753] The state also controlled the opening, the closing, and above all the management and maintenance of canals for irrigation.[1754]

Obviously, the thriving Islamic trade (local and foreign) contributed largely to such developments in farming. Farmers were lured by high profit, and so introduced higher yielding new crops and better varieties of old crops.[1755] For the same ends, they encouraged specialised land use, intensive cultivation, rotation of crops, improved irrigation techniques, land improvement in hitherto abandoned areas, and development of more labour intensive techniques of farming. The enlargement of the money economy and the growth of population with its increasing urbanisation also contributed to this.[1756] The Muslim agricultural revolution, Watson correctly notes, was bound to a demographic revolution which seems to have touched most parts of the Islamic world from roughly the beginning

[1750] E. Teres: le Development de la Civilisation Arabe a Tolede; in *Cahiers de Tunisie*, vol 17-8; 1969-70; pp. 73-86. at p. 73.
[1751] See part one under gardens; and above under various sub-headings.
[1752] In Al-Masu'di: *Muruj al-Dahab;* ed and trans C. Barbier de Meynard and P. de Courteille as *Les Praies d'or* (Paris 1861-77), vol vii; p.104.
[1753] P. Guichard: Mise en valeur; op cit; p. 182.
[1754] Ibid.
[1755] A.M. Watson: *Agricultural*, op cit; pp 2-3.
[1756] See chapter above on urbanization and trade; and consult: M. Lombard: *The Golden Age;* op cit.

of the 8th until the end of the 10th century.[1757] This demographic revolution was, of course, tied to other simultaneous developments affecting Islamic society, some we have seen, others still to be considered. Improved economic conditions, such as better urban facilities, greater stability and order provided by the powerful Islamic state of early centuries, all seen in Part One of this work, added to the flowering of medical sciences,[1758] and the construction of hospitals throughout the Islamic world.[1759] These surely accounted for the major demographic boom. Rising population and increasing output of foodstuffs must have continuously interacted: at times, demographic increase may have been the result of agricultural progress, at times its effective cause.[1760] The rising population also had the effect of creating continuous settlements, which improved communications, speed of diffusion, the spread of trade, which all in turn stimulated the growth of agriculture.[1761] Villages grew larger, and in heavily irrigated parts, they became more nearly contiguous so that settlement was almost continuous especially along the great river valleys. The author of *Minhaju-l-fakar*, thus, refers to the river that flows through the city of Seville:

> 'Its banks are covered with fruit trees, forming a sort of canopy over the river, so that one may sail in it sheltered from the rays of the sun, and listening to the charming melody of the singing birds. The journey along its banks is equally pleasant, and one may travel the distance of ten parasangs (thirty miles) through clusters of buildings and farm houses, high towers and strong castles, forming a continued city. The amount of taxes paid by the city of Seville alone, during the caliphate of Al-Hakem Ibn Hisham is stated at one hundred and thirty five thousand dinars.'[1762]

This increase in numbers was not just responsible for increased demand for foodstuffs, which in turn encouraged agricultural advances, it also supplied a larger labour force to run this labour intensive sector.[1763] So great was the increase in food production, it fed not just the rural population, but also the vastly increased urban population. For instance,

[1757] A.M. Watson: A Medieval Green Revolution; op cit; p. 44.
[1758] See. I.e. L. Leclerc: *Histoire;* op cit.
M. Levey: *Early Arabic Pharmacology* (Leiden, E.J. Brill, 1973).
[1759] See A. Whipple: *The Role of the Nestorians and Muslims in the History of Medicine.* Microfilm-xerography by University Microfilms International (Ann Arbor, Michigan, U.S.A. 1977), chapter devoted to hospitals.
A Issa Bey: *Histoire des hopitaux en Islam* (Beirut; Dar ar ra'id al'arabi; 1981).
[1760] A.M. Watson: A Medieval Green Revolution; op cit; p. 44.
[1761] Ibid; p. 45.
[1762] In Al-Maqqari: *Nafh Al-Tib.* Translated by P. De Gayangos; op cit; vol 1; p.56.
[1763] A.M. Watson: A Medieval Green Revolution; op cit; p. 45.

the population of Baghdad rose from 500 inhabitants in 762 to nearly 2 million in 800;[1764] Kufa reached 100,000 inhabitants, and Basra 200,000 in the space of three decades;[1765] Seville contained 500,000 inhabitants; Almeria an equal number; Toledo 200,000,[1766] and Cordoba's population could have been in the vicinity of a million.[1767] This vastly increased urbanisation put the onus on the countryside to produce more foodstuffs, and as a result, the areas of land that were directly pulled into this sphere of the urban economy must have been very large.[1768] Also, of course, in an effort to meet such vast demand, the need to raise productivity on the land, through all the innovations and techniques elaborated upon above, was stimulated further. The rural dependence on the cities had further impact in leading to the specialisation of rural labour, stimulating further the growth of urban industries, and enlarging a class of intermediaries such as transporters, financiers, warehouse owners, etc.[1769]

In farming, just as in learning, finally, piety and performing worldly deeds were on equal par and, on this, Scott tells how the Muslim, mindful of the Qura'nic precept that inculcates industry as a virtue and stigmatises idleness as a crime, was the most laborious and successful of agriculturists, the most skilful of artisans.'[1770] Constant, indeed, is the Qura'nic urge to labour and make the land fruitful.

7. Aftermaths of Islamic Farming:

The decline of Islamic farming, just as other aspects of Islamic civilisation, as the last part of this work will abundantly show, began with the many invaders of the Islamic world, from the Banu Hillal in North Africa (1057), to the Crusaders (1095-1291) to the Mongols (13th century), Timur Lang (late 14th century), and so on. These invasions

[1764] M. Lombard: *The Golden*; op cit; p. 118.
[1765] Ibid; p. 123.
[1766] S.P. Scott: *History*: op cit; vol 1; pp 613-4.
[1767] In Al-Maqqari: *Nafh Al-Tib. Vol 1; pp.* pp. 214-5.
[1768] A.M. Watson: A Medieval Green Revolution; op cit; p. 45.
[1769] See Labib: *Handelsgeschichte Agyptens im Spatmittelalter* (Wiesbaden; 1965), pp. 182; 339;
P. Casanova: Essai; op cit;
A.M. Watson: A Medieval Green Revolution; op cit; p. 48.
[1770] S.P. Scott: *History,* Vol II, op cit; p.219.

destroyed crops and orchards, closed down trade routes, destroyed irrigation and water supply, and caused farmers to take flight.[1771] Everywhere the Muslims fell under the Christian foe, from being land owners, they were made into slaves or serfs tied to the estates of their new masters. In the East (the Holy Land and Cyprus), during the crusades, most of the Muslims who had converted to Christianity were made into serfs or slaves, and Muslim slaves were added from time to time to the labour force.[1772] In Spain, following the Christian taking of the country in the 13th century, Muslim farmers became over taxed by their new Christian masters; in the Kingdom of Valencia the Muslims who remained were mainly in mountainous regions where grazing and non intensive agriculture were practiced.[1773] In Sicily, too, the Muslims gradually became concentrated largely in mountainous regions.[1774]

When, eventually, the Muslims were wiped out in both Christian Spain and Sicily, their system perished with them.[1775] Writing early in the 20th century, Scott reminds how, in Spain, 'where once were endless plantations of valuable trees are now dreary wastes destitute of all vegetation, incapable of supporting animal life.'[1776] Lane Poole, earlier had held, that the Spaniards:

> 'Were never able to do justice to the rich soil of Andalusia. So little did the crown think of the fertile country about Granada that in 1591 the royal domains there were sold, because they cost more than the Spaniards could make them yield. In the time of the Moors the same lands were gardens of almost tropical luxuriance.'[1777]

The particular instance of the sugar industry serves to illustrate this very well. The industry reached its peak in the 14th century in the still Islamic parts of Spain: Almeria, Granada and Malaga. Balaguar y Primo estimates that at the time the area was 400,000 marjales in those parts, and 180,000 marjales in the rest of the coastal are (the marjal is given by him as 0.05 ha or 0.125 acre, and he states that the yields accepted by the Muslims was 290 arrobas (7,250 lb., of cane per marjal, which reduces to 26 tons

[1771] See final chapter in A. Watson: 'Agriculture in retreat,' in A. Watson: *Agricultural*, op cit.
[1772] Ibid; Note 20; p. 211.
[1773] T. Glick: *Irrigation and Society in Medieval Valencia* (Cambridge mass; 1970), p. 231, fwd.
[1774] A. Watson: *Agricultural;* op cit; Note 21; p.211.
[1775] See H.C. Lea: *A History of the Inquisition;* op cit; volume three, pp 317-410.
[1776] S.P. Scott: *History;* op cit; vol 2; p. 615.
[1777] S. Lane Poole: *The Moors;* op cit; p. 275.

per acre; thus a yield of 206,761 tons of sugar or 11.2% on cane).[1778] After the conquest of Grenada in 1492, and the expulsion of the Muslims, the industry languished, even though attempts were made to continue its cultivation with African slaves. A further setback was caused by the expulsion of the Muslims from Spain in 1609.[1779] Of this period Balaguer y Primo writes:

> 'In proportion as the Moriscos left our soil, so began a great decadence in sugar production, which continued to fall rapidly for this reason, and for others, which there is no reason to mention here. Motril alone between the 16th and 18th centuries lost many mills, and at the beginning of the 19th century there did not remain in Andalusia more than 9,700 marjales (1,225 acres) of cane, reducing according to Bowles, the number of mills from the seven mentioned above to four by 1800. During the 18th century there disappeared the rich cane fields of Castellon de la Plana, and those of Valldigna, Bennerda, Benipeixar and Grandia grew less in area, and at the close of the century (in 1779), the factory near Lobres was closed.'[1780]

Devastated by the medieval invaders, fallen under new Christian rule, the Islamic farming legacy was finished off by modern Western colonisation. This final intrusion, which began in the 18th century, seriously upset the traditional agricultural balance in order to increase profitability for the colonisers.[1781] Wolf explains how the victory of the East India Company (1750s and after) over the Mughals gave it and its officials the means to subordinate Indian resources for 'the process of accumulation in the home country,' thus siphoning wealth out of country, and impoverishing the local industry.[1782] England also reorganised Indian land tenure and land taxation to make Indians pay not just for the expenses of warfare, but also to cover the cost of continuous English occupation. Land and tax reform were also used to reorient Indian agriculture toward the production of profitable commodities, such as raw cotton and opium, to enhance England's commerce with China.[1783] These measures, and looting of the

[1778] Balaguar y Primo: *Cultivo de la Cana de Azucar* (Madrid; 1877), pp. 28 and seq.
[1779] N. Deerr: *The History*; op cit; p. 81.
[1780] Balaguar y Primo: *Cultivo de la Cana;* op cit; pp. 28 and seq.
[1781] L. Bolens: Agriculture, in *Encyclopaedia* (Selin ed), op cit, p. 22.
[1782] E. Wolf: *Europe and the People Without History* (University of California Press; Berkeley; 1982), p. 247.
[1783] Ibid.

country's riches led to terrible famines, which claimed millions of lives amongst Muslims and Hindu alike.[1784]

Wolf also expands on the effects the Dutch had on their most prized possessions in the southern seas, the Moluccas, which were the source of cloves, nutmeg, and the nutmeg fleece called mace. To ensure control, the Dutch in 1621, exterminated or deported the local people to Batavia, to be replaced by Dutch colonists who were granted land tracts planted with nutmeg trees, together with the services of Company slaves for cultivation.[1785]

In Algeria, on arrival, in 1830, the French found a much greener country than the one they left 130 years later, and a population living more or less in harmony with its environment. In their wars of devastation against Algerian resistance (1830s-1840s), the French destroyed garden rings surrounding towns and cities, and cut and uprooted trees and orchards. Once they settled the country (1860s-1940s) they deforested nearly the entire coastal northern regions to exploit timber, and also forced Muslim farmers off fertile lands on to marginal lands, causing the permanent degradation of such lands. Later, during the war of independence (1954-62), the French set ablaze millions of acres of forests, besides ravaging the rural economy; and then departed, leaving a legacy of bareness and even hostility to greenery from which the Algerians have not yet recovered.[1786]

[1784] W. Howitt: *Colonisation and Christianity* (Longman; London; 1838), pp. 256 ff.
[1785] E. Wolf: *Europe;* op cit; p. 238.
[1786] Good accounts of such French devastation can be found in the following:
-C.R. Ageron: *Histoire de l'Algerie contemporaine*, 3 vols (Presses Universitaires de France, 1979).
-C.A. Julien: *Histoire de l'Algerie Contemporaine* (Presses Universitaires de France, 1964).
-H. Alleg et al: *La Guerre d'Algerie* (Temps Actuels, Paris, 1981).

ASTRONOMY AND OBSERVATION

Writing on the Islamic impact in astronomy, Rybka does not fail to make the customary remark how in the history of astronomy little attention is given to the Islamic role in the progress of the science. Pannekoek, for instance, only devotes seven pages to the subject,[1787] and the Muslim theory of planetary motion, hardly taking any interest in his work, and even Dreyer is also guilty of some neglect.[1788] In both books, Rybka points out, there prevails the same defect observed in most other works, namely that the role of Muslim astronomers was simply to transmit what was found in Ptolemy's *Almagest.*[1789] Pannekoek, hence, says:

> 'The Muslims did not go beyond Ptolemy, and when they did, it was from preference to Aristotle.'[1790]

And:

> 'There was a brilliant rise in Arabian astronomy, but no significant progress. After some centuries it died down.'[1791]

Then, the same author concludes his short outline on Muslim astronomy, saying that:

> 'Arabian scientists certainly observed diligently; they constructed new instruments, and in astronomy they seem to have displayed more practical activity than did the Greeks. Also the accuracy of their work often surpasses the results of Antiquity. Their aim, however, was not to further the progress of science-this idea was lacking throughout-but to continue and to verify the work of their predecessors.'[1792]

[1787] *A.* Pannekoek*: A History of Astronomy* (George Allen and Unwin Ltd; London; 1961).
[1788] E. Rybka: Mouvement des Planetes dans l'Astronomie des Peuples de l'Islam; in *Convegno*; op cit; pp. 579-93; at p. 579.
[1789] Ibid.
[1790] *A.* Pannekoek*: A History of Astronomy;* op cit; p. 170.
[1791] Ibid.
[1792] Ibid; p.169.

This view is shared by the overwhelming majority of historians, such as Duhem, in whose words:

> 'The revelations of Greek thought on the nature of the exterior world ended with the ''Almagest," (by Ptolemy) which appeared about A.D. 145, and then began the decline of ancient learning. Those of its works that escaped the fires kindled by Mohammedan warriors were subjected to the barren interpretations of Mussulman commentators and, like parched seed, awaited the time when Latin Christianity would furnish a favourable soil in which they could once more flourish and bring forth fruit.'[1793]

A view shared by Perroy:

> 'All or nearly all (Muslim astronomers), follow the practice of plagiarism of the Middle Ages, inspiring themselves for more than half of the works of Ptolemy, whose text they copied.'[1794]

Dreyer tells us:

> 'Though Europe owes a debt of gratitude to the Arabs for keeping alive the flame of science for many centuries and for taking observations, some of which are still of value, it cannot be denied that they left astronomy much as they found it.'[1795]

And:

> 'When the Europeans again began to occupy themselves with sciences, they found astronomy practically in the same state in which Ptolemy had left it in the second century.'[1796]

This view is common to the overwhelming majority of writing on the history of astronomy.[1797] But there is even worse than this, i.e when Islamic astronomy is completely blotted out. J.P. Verdet, for instance, in a History of astronomy, jumps from Ptolemy to Copernicus, skipping nearly

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[1793] P. Duhem: Medieval Physics, in R. Palter edition: *Toward Modern Science* (The Noonday Press; New York; 1961), Vol 1; pp 141-159; Quote at p. 141; This article is a reprint from 'Physics, history of," *Catholic Encyclopaedia*, XII (1911), pp 47-52.
[1794] E. Perroy: Encore Mahomet et Charlemagne in *Bedeutung*; op cit; pp. 266-75, at p.271.
[1795] J.L.E. Dreyer: *A History of Astronomy from Thales to Kepler* (Dover Publications Inc, New York, 1953), p.249.
[1796] Ibid; p.279-80.
[1797] Such as in:
- O. Pedersen: *Early Physics and Astronomy* (Cambridge University Press, 1974).
-J. Delambre: *Histoire de l'Astronomie Ancienne* (Johnson Reprint Collection; New York, 1965).
-Or many Websites as seen in the late 1990s, such as at:
http://w3.restena.lu/al/pub/indivs/wagnjean/astronomy.htm#medieval

1500 years.[1798] And so does Neugebauer in his *Astronomy and History*.[1799]

These views, however, are wholly contradicted by history as seen in the following outline.

1. Islamic Astronomy: Inanities of Historical Writing:

First and foremost, Islamic astronomy is not a replica of Greek astronomy, nor was it stimulated in its rise by Greek astronomy. The Greek legacy in this field, as in all other sciences, was only a tool for the Muslims, a tool as good and as limited as others, the Hindu, the Chinese, the African, the Roman, and the pre-Islamic, which all acted as means (tools) for the Islamic civilisation. The Chinese source, rather than the Greek, in fact, played a much greater part than any other in the thriving Islamic civilisation. This has already been partly seen in the first part of this book, and the chapters on the diverse sciences, in this part, will confirm this point. The following will also confirm, and highlight that the foundation of Islamic science, the real inspiration, comes not from Greece but from the faith, i.e Islam. The final part of this work will make this point abundantly clear. But here, in relation to the subject of astronomy, it is worth beginning by showing how faith inspired the rise of Islamic astronomy.

a. The Role of Islam in the Rise of Astronomy:

Hoskin and Gingerich provide a good introductory section on Islamic astronomy in one of their latest works.[1800] In a five or so pages, they detail how observation of the faith confronted Muslims with problems they had to resolve, which led to their developing aspects of mathematical

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[1798] J. P. Verdet: *Une Histoire de l'Astronomie* (Le Seuil, Paris, 1990).
[1799] O. Neugebauer: *Astronomy and History* (Verlag, 1983).
[1800] M. Hoskin and O. Gingerich: Islamic Astronomy; in *The Cambridge Concise History of Astronomy;* ed by M. Hoskin (Cambridge University Press; 1999), pp. 50-62.

astronomy to resolve such problems.[1801] The following is a brief outline of this section, which, without a doubt, will not express the argument as eruditely as Hoskin and Gingerich did.

The religious practices of Islam generated three specific challenges to which mathematical astronomers attempted to find solutions. The first arose out of the lunar calendar, each month beginning with the new moon, when the lunar crescent was first sighted in the evening sky. If the crescent was seen, it would signify the beginning of the month, such as the month of fasting (Ramadhan,) or the end of it, etc. The problem remains that skies are not always clear, and even if they were, watchers in different places might not see the moon. To resolve this problem, Muslim astronomers followed criteria found in Indian sources, as well as those found in Ptolemy, which, however helpful, failed to provide adequate answers. Muslim astronomers had to compile sophisticated tables to assist in the resulting calculations, leading to the production of almanacs with information on the possibility of sightings around the beginning of each month.

The second religious requirement that involved astronomy concerned the times of prayer, the number of which was five: sunset, nightfall, daybreak, midday and afternoon. The timing of the latter two, plus that of a voluntary mid-morning prayer, corresponds to the ends of the third, sixth and ninth of the (variable) hours of daylight. Finding the exact time of the day from the altitude of the sun or the time of night from the altitude of bright stars was resolved in Baghdad in the 9th century. By this century, the medieval equivalent of the six modern trigonometric functions had been recognised, whereas Ptolemy had operated with only a single chord. Islamic astronomers discovered basic trigonometric identities that greatly simplified calculations involving triangles on the celestial sphere. The institution of the muwaqqit, time keeper, in mosques, gave competent astronomers a central institutional foundation from which to operate, and it led to a rapid increase in the quantity and quality of astronomical writings.

The third challenge relates to the orientation of both prayers and mosques in direction towards Makkah from any place in the world. Muslim astronomers applied their minds to resolve the problem of how to determine the *qibla* (sacred orientation) mathematically using available geographical data. Formulae in spherical trigonometry were developed and tables calculated from them. One outstanding achievement, dating possibly from the 11th century, was the development of cartographic grids

[1801] Ibid; at pp. 52-7.

for Makkah-centred world maps, from which one could read off the qibla and distance to Makkah directly.[1802]

Highlighting further the intricate link between faith and science is the fact that in the Islamic experience, both science and faith rose simultaneously (8th century), a unique fact in history, and Islamic science and power declined simultaneously, too, in the 13th century. This matter will be examined at greater length in the final part of this work. Here, the instance of astronomy is very enlightening as far as proving a direct link between the faith and the enthusiasm for scientific query, going further than the factor of religious necessity already looked at in the previous paragraphs. We read incessantly accounts by Muslim astronomers declaring their enthusiasm for the science in their quest for religious truth, stimulated by the fact that Islam is free of miracles, and thence, reason is the road towards religious discovery. Hence, one of Islam's earliest astronomers, Habash Al-Hasib (d. 865) says:

> 'Among the very favours which God bestowed upon the people of past generations… He had endowed them with intellects through which it became possible for them to gain clear and precise knowledge, so that this capacity of theirs led them to a discriminating and penetrating enquiry into the constitution of the heavenly spheres and the laid out land, their harmonious relations, and their mutual adaptations and connections. They thereby grasped the implications of God's words and penetrated the inner meaning of his tidings. They thus inferred from the visible features of the firmament its more secret implications and from its appearances its hidden truths; they reached the conviction that it has a creator who brought it into being and originated it and that there was no question of a process whereby some of its parts caused existence of others.'[1803]

Al-Battani (d. 929), likewise, says of astronomy that it is a field of endeavour with an invigorating effect on the intellect and sharpens the faculty of reflection, and that this science makes possible the knowledge of the length of the year, the months, the different times and seasons, the positions of the sun and the moon as well as their eclipses, and the courses of the planets and their direct and retrograde motions, the alterations of their forms, and the arrangements of their spheres, which leads people, who reflect deeply and persistently, to the proof of the unity of God and to

[1802] Ibid.

[1803] A. Sayili: The Introductory section of Habash's Astronomical Tables; *Ankara Universitesi Dil ve Tarikh Cografya Fakultesi Dergisi*; vol 13; No 4 (1955), p. 140.

the comprehension of His majesty, to His immune wisdom, infinite power, and to the grasp of the excellence of His act.[1804] Then, as frequently found in books on astronomy, al-Battani quotes from the Qur'an in support of ideas such as those expressed above. He cites verses such as the following, adding that many others of the same nature could be mentioned:

> 'Verily, in the creation of the heavens and of the earth, and in the succession of the night and of the day, are marvels and signs for men of understanding heart. (Sura III; verse 187); Blessed be He who has placed in the heaven the signs of the zodiac, who has placed in it the lamp of the sun and the light giving moon. (XXV; 62). It is he who has appointed the sun for brightness, and the moon for a light, and has ordained her station that you may learn the number of years and the reckoning of time (X; 5)…
>
> Speaking to al-Qifti (d. 1248), Al-Sabti (d. 1226) stated that there was no heresy in astronomy, and that 'on the contrary, it is a road leading to faith and to a knowledge of the power of God… through a study of what He has ordered and arranged.'[1805]

Al-Urdi (d. 1266) holds that the excellence of each science comes either from the excellence of its subject or from the solidity of its proofs, or that it may come from both, and he says that this latter case is true of astronomy; for its subject matter deals:

> 'with God's most admirable achievements, the most magnificent He has created, and the most sagacious of His acts, and its proofs are geometrical and arithmetical and therefore clear and final,'[1806]

and he concludes that astronomy leads to the science of theology and gives evidence of God's magnificence.[1807]

This is a common line amongst most Muslim astronomers, all acknowledging the same fervour for the science on the same lines, and all bringing together science, theology, the magnificence of creation and fabulousness of the universe.

Just as the foundations of Islamic astronomy are not Greek, Islamic astronomy is no reproduction of Greek astronomy, either.

[1804] Al-Battani: *Al-Zij Al-Sabi*; Ed. Nallino (Rome; 1944), vol 5; pp. 6-7.
[1805] Ibn al-Qifti: *Tarikh al-Hukama;* ed. Lippert (Berlin; 1903), pp. 228-9.
[1806] Al-Urdi: *Kitab al-Hay'a;* Ms. Konya; Yusuf Aga Library; No 6829; p. 1b.
[1807] Ibid.

b. Greek Vs Islamic Astronomy:

The assertion that Islamic astronomy is a mere reproduction of Greek astronomy is groundless as this chapter will abundantly show. Briefly are considered here some fundamental differences between Islamic and Greek astronomy.

First, Muslim astronomers dealt with a considerable number of subjects Ptolemy never addressed or contemplated, or could even address or contemplate, all subjects, which are today the realm of modern astronomy. The briefest set of instances will show that it is not in Ptolemy that one finds trigonometrical calculations relating to this subject,[1808] nor the many calculations, findings, and theories that the hundreds of Muslim astronomers made,[1809] nor the use of observation for scientific purposes.[1810] Ptolemy's tables did not stand in comparison with Muslim tables, such as al-Zarqali's for instance.[1811] It was also the Muslims who initiated the greatest breakthroughs in the issue of planetary theories, and not Ptolemy or other Greek astronomers.[1812] Moreover, contrary to Ptolemy, Muslim astronomers such as al-Sijzi (fl late 9th century) did conceive that the earth was moving in its own axis.[1813] This is further confirmed by another astronomer of the 13th century, Al-Harrani, who held 'according to the geometers (or engineers) (*muhandeseens*), the earth is in constant circular motion, and what appears to be the motion of the

[1808] See: A. Nallino: *Albateni Opus Astronomicum* (Arabic text with Latin translation), 3 vols (Milan 1899-1907 reprinted Frankfurt 1969).
G. Sarton: Introduction; op cit; vol 2, most particularly.
[1809] H. Suter: *Die Mathematiker und Astronomen der Araber und ihre Werke* (1900; reprint APA, Oriental Press, Amsterdam, 1982).
[1810] A Sayili: *The Observatory in Islam*, Turkish Historical Society (Ankara, 1960).
B. Hetherington: *A Chronicle of Pre-Telescopic Astronomy* (John Wiley and Sons; Chichester; 1996).
[1811] M. Steinschneider:
Etudes sur Zarkali; *Bulletino Boncompagni*; vol 20.
Notice sur les tables astronomiques attribuees a Pierre III d'Aragon (Rome, 1881).
[1812] J. North: *Astronomy and Cosmology* (Fontana Press, London, 1994).
G. Saliba: Critiques of Ptolemaic astronomy in Islamic Spain; in *Al-Qantara*, Vol 20 (1999); pp 3-25.
[1813] G. Saliba: Al-Biruni; in *Religion, Learning and Science in the Abbasid Period;* Ed by M.J.L.Young; J.D. Latham; and R.B. Serjeant (Cambridge University Press; 1990) pp. 405-23; p. 413.

heavens is actually due to the motion of the earth and not the stars.'[1814] Muslim astronomers, besides exploring issues never addressed by Ptolemy, refuted him, and even ridiculed him.[1815] This will be made particularly obvious in the section dealing with Andalusian astronomers.

The second most important difference between Islamic and Greek astronomy is that, unlike its Greek predecessor, Islamic astronomy was not just the work of a handful of figures, in fact, mainly a lone figure (Ptolemy), but literally that of hundreds. Suter, early in the 20th century, listed over 500 Muslim astronomers,[1816] a figure since augmented considerably by Sarton[1817] and Sezgin.[1818] A recently published work by Rosenfeld and Ihsanoglu has made an up-date of the works and accomplishments of hundreds of Muslim astronomers whose scope was far reaching, and had considerable influence on modern astronomy.[1819]

Thirdly, Islamic astronomy was universal in its character, and as to be seen below under Observation, it generally involved teams of workers in specified tasks. Illustrating this universal-team work character is the fact that often, even members of the same family collaborated. The three Banu Musa bothers, for instance, made observations and worked on diverse scientific subjects in a collaborative effort.[1820] The same with Ibn Amajur, the father, who made observations between 885 and 933, with his son Abu-l Hasan Ali and an emancipated slave named Muflih.[1821] They were some of the greatest observers of Islam, father and son, and Muflih, making many observations, and producing numerous astronomical

[1814] Ahmad b. Hamdan al-Harrani: *Kitab jami al-funun;* British Library; Ms Or..6299., fol. 64v.
[1815] See the following for an abridged outline of Islamic destruction of Ptolemy's astronomy by Al-Battani in P Benoit and F. Micheau: The Arab intermediary; op cit; p. 203. by Al-Zarqali in P.K.Hitti: *History of the Arabs* (MacMillan, London, 1970 ed), p. 571. by Al-Bitruji in A. Djebbar: *Une Histoire;* op cit; p.194. by Jabir Ibn Afllah in F.Braudel: *Grammaire des Civilisations* (Flammarion, 1987), p.113. and G. Sarton: *Introduction*; op cit; Vol II; p.18.
[1816] H. Suter: *Die Mathematiker und Astronomen der Araber (*1900); op cit.
[1817] G. Sarton: *Introduction;* op cit.
[1818] F. Sezgin: *Geschichte des arabischen Schrifttums* (vol vi for astronomy); 1978.
[1819] B. Rosenfeld and E. Ihsanoglu: *Mathematicians, Astronomers and Other Scholars of Islamic Civilisation*; Research Centre for Islamic History, art and Culture; Istanbul; 2003.
[1820] D. Debagh: Banu Musa; in *Dictionary of Scientific Biography*; Editor Charles C. Gillispie (Charles Scribner's Sons, New York, 1970 ff). Vol 1; pp 443-6.
[1821] G. Sarton: *Introduction*; vol 1; op cit; p. 630.

tables.[1822] There is also the mention of another member of the family, and collaborators working with them.[1823]

Fourthly, and more importantly, very early, Muslims astronomers, like other Muslim scientists, insisted on the need not just for observation and calculation, but also repeated verifications of results. Briffault notes how Muslims compiled new sets of planetary tables, and obtained more accurate values for the obliquity of the ecliptic and procession of equinoxes, that were checked by two independent measurements of a meridian the estimates of the size of the earth.[1824] Al-Biruni and Abu'l Wafa (940-998), for instance, made in the year 997 arrangements to observe the lunar eclipse of that year and compare notes; Abu'l Wafa observing it in Baghdad while al-Biruni made the observation in Khwarizm.[1825] The search for accuracy was such that on the inaugural observations made at the 10th century Sharaf al-Dawla Observatory of Baghdad, for instance, official documents were drawn up testifying to the accuracy of the instruments and the observations, and jurists were among the signatories of these documents.[1826] To reach ever more precise results, Muslim astronomers devised more precise and larger instruments, which is the fifth main difference with Greek astronomy.

Fifthly, instruments built by Muslim astronomers surpass anything Greek astronomy did.[1827] Muslim astronomers, for instance, defined their findings, and devised their astronomical tables through observations and calculations, and using for the first time sophisticated apparatus for such operations.[1828]

[1822] E.S. Kennedy: A Survey of Islamic Astronomical Tables; *Transactions of the American Philosophical Society;* New Series; vol 46; part 2 (1956); pp. 125; 134; 135.
[1823] Ibn al-Qifti: *Tarikh al-Hukama;* op cit; pp. 220-1.
[1824] R. Briffault: *The Making*, op. cit, p. 193.
[1825] Al-Biruni: *Tahdid Nihayat al-Amaqin li tashih Masafat al-Masakin;* Istanbul; Sulaymaniye Library; Fatih-3386; p. 275.
[1826] A Sayili: *The Observatory in Islam*, op cit; p. 27.
[1827] See, for instance,
A. L. Sedillot: Memoire sur les instruments astronomique des Arabes, *Memoires de l'Academie Royale des Inscriptions et Belles Lettres de l'Institut de France* 1: 1-229 (Reprinted Frankfurt, 1985).
L.A. Mayer: *Islamic Astrolabists and Their Works* (Albert Kundig; Geneva; 1956).
[1828] See for instance:
A. L. Sedillot: *Memoire*; op cit;.
B. Hetherington: *A Chronicle of Pre-Telescopic Astronomy* (John Wiley and Sons; Chichester; 1996).
R.P. Lorch: The Astronomical Instruments of Jabir Ibn Aflah and the Torquetom; *Centaurus,* (1976) vol 20; pp 11-34.

Al-Battani recommends for parallax measurements the use of the large, or huge, quadrant and the parallactic ruler.[1829]

The following highlights further the points just made, and dwells on the various Muslim accomplishments in the field.

2. The Accomplishments of Muslim Astronomy at a Glance:

Astronomy was one of the earliest sciences to thrive in Islam. In the 8th century, Al-Fazari (d.777) became the first to construct astrolabes. The astrolabe was a multi functional instrument that served for nearly ten centuries to make all sorts of calculations. Al-Fazari also wrote on the armillary sphere, and the calendar.[1830] Soon after, Mash'allah (d.815) took part with the Persian al-Naubakht in the preliminary surveying of the foundation of Baghdad in 762-763. His *De Mercibus*, is the oldest scientific work in Arabic,[1831] and was translated by Gerard of Cremona in the 12th century.[1832]

Under Al-Mamun (r. 813-833), an observatory was completed in 829, a major landmark in the history of astronomy, from which, in the year 830, the position of the solar apogee was determined at $82^0 39'$.[1833] Astronomers at Al-Mamun's court also found the inclination of the ecliptic to be $23^0 33'$.[1834] Al-Mamun also supervised two geodetic surveys in Iraq for the purpose of determining the length of a degree of the meridian, reaching a result of a degree being equal to 562/3 miles.[1835] The earth's

[1829] Al-Battani: *Kitab al-Zij al-Sabi;* ed. A. Nallino (Roma; 1899-1907), in three vols; vol 1; p. 82.
[1830] H. Suter: Die Mathematiker; op cit; in G. Sarton: *Introduction*; vol I, op cit. p.530.
[1831] Carra de Vaux: Astronomy and Mathematics, in *The Legacy of Islam*; ed by A. Guillaume and T. Arnold; First Edition (Oxford University Press; 1931), pp.376-97; at p. 380.
[1832] G. Sarton: *Introduction;* vol I, op cit; p. 531.
[1833] W. Hartner: The Role of Observations in ancient and medieval astronomy; in *The Journal of History of Astronomy*; Vol 8 (1977); pp 1-11; at p. 8.
[1834] J.L.E. Dreyer: *A History*; op cit; p.246.
[1835] Ibid.

circumference was found to be 40,253.4 kms (the accurate figure being 40,068.0 km through the equator, and 40,000.6 km through the poles.)[1836]

One of the astronomers at the court was Habash al-Hasib (d.864). A number of works are ascribed to him, and they include the *Mumtahan Zij* (The Tested Astronomical Table), The *Ma'muni Zij*; on the *Rukhamat* (Measurements); on the celestial sphere; on astrolabes; on the Oblique and perpendicular Planes; and on the Distance of the stars.[1837] He made observations of solar and lunar eclipses and of planetary positions at Baghdad, Samarra and Damascus.[1838] He compiled astronomical tables and gave the first instance of determination of time by altitude, besides introducing the notion of shadow (*umbra versa*) corresponding to our tangent, and compiling a table of tangents, probably the earliest of its kind.[1839]

Also at the court was al-Khwarizmi (d.863) better known as a mathematician, on which much will be said further on. He wrote on the astrolabe, compiled a set of astronomical tables of future planetary and stellar positions, and also became one of the first to compute astronomical and trigonometrical tables.[1840]

Al-Farghani (fl. 861) also worked at the same court. His best known work *Kitab fi Harakat Al-Samawiyah wa Jaamai Ilm al-Nujum* (The Book on the Movement of the Planets, and Compendium of the Science of the Stars) is a manual of cosmography of thirty chapters. It includes a description of the inhabited part of the earth, its size, the distances of the heavenly bodies from the earth and their sizes, and other matters. Relying on measurements made at the court, Al-Farghani made many corrections to Ptolemy.[1841] He published astronomical tables, and wrote about sundials.[1842] He gave the radius of the earth at 3250 miles, and the greatest distance to the moon as 64 1/6, Mercury 167, Venus 1120, the sun 1220, Mars 8876, Jupiter 14405, and Saturn 20110 earth radii respectively; gave the apparent diameter of the sun and moon as 31 2/5, and the apparent

[1836] M. A. Kettani: Science and Technology in Islam: The underlying value system, in *The Touch of Midas; Science, Values, and Environment in Islam and the West*; Z. Sardar ed (Manchester University Press, 1984), pp 66-90; at p. 75.
[1837] S. Tekeli: Habash al-Hasib; *Dictionary of Scientific Biography*; vol 5; pp. 612-20; at p. 612.
[1838] G. Sarton: *Introduction;* vol I, op cit; p.545.
[1839] Ibid.
[1840] Ibid.
[1841] R. Morelon: Eastern Arabic Astronomy, in *Encyclopaedia (Rashed ed) op* cit; pp 20-57; at p. 24.
[1842] W. Mackenzie: *The Imperial Dictionary of Universal Biography*; Six volumes (London; 1880?); vol 1; p. 100; D. E. Smith: *History of Mathematics* (Dover Publication; London; New York; 1958); vol 1; p. 170.

diameters of the planets at mean distance as Mercury 1/15, Venus 1/10, Mars 1/20, Jupiter 1/12, and Saturn 1/18 solar diameters.[1843] Amongst Al-Farghani's other contributions are his establishment of the Nilometer of Fustat (old Cairo), and two unpublished treatises one on the astrolabe, and the other on the construction of sundials.[1844] Gerard of Cremona translated his *Liber 30 differentiarum* also known as *Compilatio astronomica;*[1845] and through much of the centuries to follow this work remained much prized through the Latin and Hebrew translations.[1846]

Much of modern astronomy derives from the pioneering studies of Al-Battani (d.929). For the major part of his life, Al-Battani worked at al-Raqqa on the Euphrates. He made observations from 877 onwards, which ended in the compilation of a catalogue of stars for the year 880, and the accurate determination of astronomical coefficients. His Sabian Tables (*al-Zij al-Sabi*) had great impact on his successors, Muslim and Christian, in equal measure.[1847] This Zij or collection of astronomical tables with rules for their use, is one of the very few works of its kind published in a modern, critical edition.[1848] The arrangement of the 57 chapters in it, unlike Ptolemy's *Almagest*, is dictated by practical rather than theoretical considerations.[1849] Al Battani starts his Zij with purely practical definitions and problems: the division of the celestial sphere into signs and degrees, and prescriptions for multiplication and division of sexagesimal fractions.[1850] It includes a trigonometrical summary wherein not only sines, but tangents and cotangents, are regularly used.[1851] It contains a table of cotangents by degrees and a theorem equivalent to the modern formula giving the cosine of a side of a spherical triangle as function of the cosine of the opposite angle and of the sines and cosines of the other sides.[1852] Known in the Latin Middle Ages as the *De scientia stellarum*, it was influential in

[1843] G. Sarton: *Introduction*; op cit; vol 1; p. 567; J.L. E. Dreyer: *A History of Astronomy*; pp. 257 and 288; in B. Hetherington: *A Chronicle*, op cit; p.94.
[1844] H. Suter: *Die Mathematiker*; op cit; pp. 18-9.
[1845] Also translated by J. Hispalensis (Ferrara 1493; later printed by Melanchton (Nuremberg 1537), New Latin translated by Golius 1669; reprinted (Frankfurt; 1986), also translated in 13th century into Hebrew by J. Anatoli.
[1846] G. Sarton: *Introduction;* op cit; vol 1; p.545.
[1847] R. Morelon: Eastern Arabic; op cit; pp. 46-7.
[1848] A. Nallino: *Albateni Opus Astronomicum* (Arabic text with Latin translation), 3 vols (Milan 1899-1907 reprinted Frankfurt 1969).
[1849] W. Hartner: Al-Battani; *Dictionary of Scientific Biography;* op cit; vol 1; pp. 507-16; at p. 508.
[1850] Ibid.
[1851] G. Sarton: *Introduction,* vol I, op cit; p.585.
[1852] Ibid.

select circles in medieval Europe after it had been translated into Latin by Robert of Chester (lived in Spain 1141-1147). Another version was by made by Plato of Tivoli (lived in Barcelona about 1134-1145) at about the same time.[1853] It impacted most particularly on Abraham Ibn Ezra, Richard of Wallingford; Levi Ben Gerson; Regiomontanus; Peurbach; and Copernicus.[1854]

Al-Battani's other accomplishments were many. Amongst others, he determined the longitude of the sun's apogee at 83^0 15'; he also gave the greatest distance of the moon as 641/6, Mercury 166, Venus 1070, the sun 1146, Mars 8022, Jupiter 12924, and Saturn 18094 earth radii respectively.[1855] Al-Battani also discovered the motion of the solar apsides,[1856] besides working on the timing of the new moons, the length of the solar and sideral year, the prediction of eclipses, and the phenomenon of parallax, carrying us according to Wickens 'to the verge of relativity and the space age.'[1857] Al-Battani fixed precisely the 'Obliquity of the Ecliptic' i.e the inclination of the celestial equator with reference to the Zodiacs at 23^0 35'.[1858] Al-Battani's observations of eclipses made in the 10th century were still used as late as 1749 for comparative purposes.[1859] His improved tables of the sun and the moon helped him discover that the direction of the sun's eccentric as recorded by Ptolemy was changing, which means that the earth is moving in a varying ellipse.[1860] Al-Battani was sceptical of Ptolemy's practical results, and relying on his own observations, he corrected Ptolemy's errors.[1861] The corrections cover the main parameters of planetary motion no less than erroneous conclusions drawn from insufficient or faulty observations, such as the invariability of the obliquity of the ecliptic or of the solar apogee.[1862] According to Al Battani:

[1853] J. North: *The Fontana History of Astronomy and Cosmology* (Fontana Press; London; 1994), p. 187-8.
[1854] Ibid.
[1855] G. Sarton: *Introduction;* 1; 602; W. Mackenzie: *The Imperial Dictionary*; op cit; vol 1; p. 66; J.L. E. Dreyer: *A History of Astronomy*; op cit; pp. 257. All in B. Hetherington: *A Chronicle;* op cit; p. 98.
[1856] R. Morelon: Eastern Arabic; op cit; pp. 46-7.
[1857] G.M Wickens: The Middle East as a world centre of science and medicine; in *Introduction to Islamic Civilisation*, op cit; pp 111-8; at pp. 117-8.
[1858] Al-Battani: *Kitab al-Zij al-Sabi;* op cit; vol 3; p. 18.
[1859] W. Montgomery Watt: *The Influence*; op cit; p. 35.
[1860] C. Singer: *A Short History of Scientific Ideas to 1900,* (Oxford University Press, 1959); p. 151
[1861] W. Hartner: Al-Battani; op cit; p. 510.
[1862] Ibid.

'After having lengthily applied myself in the study of this science (astronomy), I have noticed that the works on the movements of the planets differed consistently with each other, and that many authors made errors in the manner of undertaking their observation, and establishing their rules. I also noticed that with time, the position of the planets changed according to recent and older observations; changes caused by the obliquity of the ecliptic, affecting the calculation of the years and that of eclipses. Continuous focus on these things drove me to perfect and confirm such a science.'[1863]

After he had completed pinpointing and demonstrating diverse astronomical operations, which he supported by mathematical calculations, Al-Battani summoned others after himself: 'to continue observation, and to search,' saying that it was no impossibility that with the passing of time, more could be found, just as he himself had added to his predecessors. 'Such is the majesty of celestial science, so vast, that none could ever encompass its study by himself.'[1864]

One of the major contributions of al-Battani to the science was his use of the widest variety of instruments. He used an astrolabe in connection with a problem which did not require a very exact measurement.[1865] There occurs a gnomon for careful observations which was divided into twelve parts but was capable of divisions into smaller fractions.[1866] He had sun clocks both horizontal and vertical.[1867] He had an armillary sphere, whose dimensions are not mentioned.[1868] He used parallactic rulers whose dimensions are not known with certainty, but he recommends the use of one whose measurements are equivalent to those performed on a circle of about five meters diameter.[1869] He had a mural quadrant; for this instrument he recommends a radius of not less than one meter, and adds that the larger the dimension the more exact it becomes.[1870] His opting for the largest instruments is evident, and the measures taken by the parallax rules relate to a circle of no less than five meters in diameter; and the quadrant was no less than one meter.[1871] Speaking of measurements of the obliquity of the ecliptic, he says:

[1863] In Barron Carra de Vaux: *Les Penseurs;* op cit; pp. 208-13.
[1864] Ibid.
[1865] Al-Battani: *Kitab al-Zij al-Sabi;* op cit; vol 1 pp. XLV; p. 91.
[1866] Ibid; pp. 22-3.
[1867] Ibid; pp. 135-8.
[1868] Ibid; pp. 138-42; and 319-21 .
[1869] Ibid; pp. 143-4; 12; 85.
[1870] Ibid; pp. 142-3; 12; 85.
[1871] Barron Carra de Vaux: *Les Penseurs;* op cit; p. 211.

'We have observed it in this time of ours with the parallactic ruler and the mural quadrant.... After having made their divisions very precise and securing them in their place as carefully as possible.'[1872]

The impact of Al-Battani on Western Christian science is considerable. Copernicus' indebtedness to him is widely known, as he quotes him fairly often, just as does Peurbach in the chapters dealing with the subjects of solar motion and of precession; and so did Tycho Brahe, Kepler and Galileo, who all showed interest in his observations.[1873] And whilst Regiomontanus valued very highly Al-Battani's spheric trigonometry, Denton profited much from his observation of the eclipses as late as 1749.[1874] Such was the impact of Al-Battani on the science, Lalande considered him one of the twenty most important scholars that ever lived.[1875]

Around the same time as Al-Battani, there flourished three astronomers of great accomplishment: Al-Sufi, Ibn Yunus, and Al-Biruni. Al-Sufi's (903-986) contribution is wide ranging, including critical revisions of Ptolemy; writing on the astrolabe (more on which further on), as well as observations on the obliquity of the ecliptic and the motion of the sun (or the length of the solar year.)[1876] He was better known for his observations and descriptions of the stars, though. He set out his results constellation by constellation, discussing the stars, their positions, their magnitudes (brightness) and their colour, and for each constellation, providing two drawings, one from the outside of a celestial globe, and the other from the inside (as seen from the sky).[1877] Al-Sufi was the first to critically revise the star catalogue of Ptolemy, adding the differing or additional results of his own observations which are embodied in his compendium: *Kitab suwar al-Kawakib al-Thabita* (On the Constellations of the Fixed Stars).[1878] The work has the exact identifications of several hundred of the old Arabic star names, and it is fairly appropriate to mention here that the Muslims named many of the stars and constellations (several of which are still with us: Aldeberan, Altair and Betelgeuse, for instance), and devised

[1872] Al-Battani: *Kitab al-Zij al-Sabi;* op cit; vol 1; p.12 .
[1873] See W. Hartner: Al-Battani; op cit; pp. 512-3.
[1874] S. Maqbul Ahmad: *A History of Arab-Islamic Geography* (Al-Bayt; Amman; 1995), p. 26.
[1875] G. Le Bon: *La Civilisation;* op cit; p.361.
[1876] R. Morelon: Eastern Arabic, op cit, p. 50.
[1877] C. Ronan: The Arabian Science; in *The Cambridge Illustrated History of the World's Science* (Cambridge University Press; 1983), pp. 201-44; at p. 213.
[1878] P. Kunitzsch: Al-Sufi: *Dictionary of Scientific Biography*; op cit; vol 13; pp. 149-50; at p. 149.

such good star maps that they were used in both Europe and the Far East for centuries to come.[1879] (To glean more on this subject of stars, there is no better authority than Kunitzsch.)[1880] Al-Sufi also wrote a book on the use of the celestial globe, and he constructed astronomical instruments as well. A silver celestial globe manufactured by him is said to have been extant in Egypt around 1043.[1881]

Ibn Yunus (d. 1009), from Egypt, is better known for his Hakemite tables, which he devised after nearly thirty years (977-1003) of observation. He, too, maintained the tradition of using a wide variety of instruments, including a large astrolabe of nearly 1.4 m in diameter. His tables contain more than 10,000 entries of the sun's position throughout the years.[1882]

Al Biruni's (973-1050) contribution to science is vast, and his name will keep on re-appearing. He wrote a total of 150 works on all the sciences of his time, including 35 treatises on pure astronomy, of which only six have survived.[1883] One of his early claims was that the earth rotated around its own axis.[1884] He also calculated the earth's circumference, and there is an exceptionally good account by Baloch on his experiment at Nandana (India) to measure the earth's circumference.[1885] Al-Biruni also fixed scientifically the direction of Makkah from any point of the globe.[1886]

Unlike what is generally asserted by mainstream historians, the overwhelming majority of Muslim scholars, whether east or west, condemned astrology.[1887] Al-Biruni, just named, spent a great deal of time in serious study of the subject,[1888] his astrological sections of *Al-Qanun al-Masudi* (The Masudi Canon) warning against belief in astrology.[1889] He goes so far as to say that he discussed astrology in detail in order to warn the intelligent man away from it.[1890] Krause has collected passages in

[1879] G.M Wickens: The Middle East; op cit; p. 117.
[1880] P. Kunitzsch: *The Arabs and the Stars: Texts and Traditions on the Fixed Stars, and Their Influence in Medieval Europe* (Variorum; Aldershot; 1989).
[1881] P. Kunitzsch: Al-Sufi; op cit; p. 149.
[1882] C. Ronan: The Arabian Science, op cit p. 214.
[1883] R. Morelon: Eastern Arabic, op cit, p. 52.
[1884] M.A. Kettani: Science and Technology: op cit, p. 76.
[1885] N.A. Baloch: Al-Biruni and his experiment at Nandana; *ERDEM*, Vol 3; No 9 (1988); pp. 673-729.
[1886] See, for instance, D.A. King: *World Maps for Finding the Direction and Distance to Mecca* (Al-Furqan Islamic Heritage and Brill; Leiden; 1999).
[1887] J.M. Millas Vallicrosa: Arab and Hebrew Contributions to Spanish Culture; in *Cahiers d'Histoire Mondiale*; vol 6 (1960), pp. 732-51, at p. 736.
[1888] E.S. Kennedy: Al-Biruni; in *Dictionary of Scientific Biography*; op cit; vol 2; pp. 147-58; at p. 156.
[1889] G. Saliba: Al-Biruni; *Dictionary of Middle Ages*; op cit; pp. 248-52; at p.250.
[1890] Ibid.

which al-Biruni not only heaps ridicule upon ignorant or unscrupulous astrological practitioners, but indicates disbelief in the basic tenets of this pseudo science.[1891] Al-Biruni's book that would have elaborated his attack against astrology is only known by name, its title, *Warning Against the Craft of Deceit*, meaning astrology, leaving very little doubt as to Al-Biruni's position on the matter.[1892]

A great number of other Muslim astronomers and scholars warned against astrology. Al-Farabi (d. 948) is one of them.[1893] Ibn Sina dwells upon the falseness of the doctrines and assumptions upon which astrology is based, and he speaks of the credulity of people with regard to their belief in astrology and similar pseudo sciences.[1894] In their defence, for making errors in their predictions, astrologers held that physicians, too, made errors,[1895] to which Ibn Sina responded that this analogy was without basis, and that in contrast to medicine, astrology lacks any scientific foundation.[1896] According to Fakhr Eddin al-Razi (d. 1209) Abu Sahl al-Masihi, teacher of Ibn Sina, was against astrology and had written a special treatise refuting it.[1897] Fakhr Eddin himself was antagonistic to it.[1898] Ibn Khaldun also attacked astrology on the ground that it had no utility and that it causes spiritual and material injury to humans.[1899] The stance against astrology in Islam follows a long tradition from the time of the Prophet who said:

> 'Those who say the rain that we receive comes from the kindness of God and from His mercy believe in me and do not believe in the stars but those who say the rain that we receive comes from the star do not believe me but believe in the stars.'[1900]

In Muslim Spain, astronomers pursued the tradition of the Muslim East, and wrote on a diversity of matters, giving a prominent place to

[1891] M. Krause: Al-Biruni. Ein iranischer Forscher des Mittelalters; in *Der Islam*; 26 (1940), pp. 1-5; at p. 10. in E.S. Kennedy: Al-Biruni; op cit; p. 156.
[1892] G. Saliba: Al-Biruni; op cit; p. 250.
[1893] F. Dietrich: *Al-Farabis Philosophische Abhandlungen;* 1890; tr. 1892 (Leiden); pp. 104-14.
[1894] M.A.F. Mehren: Vues d'Avicenne sur l'Astrologies; *Le Museon;* Vol 3 (1884), pp. 383-403.
[1895] E.G. Browne: *Arabian Medicine* (Cambridge; 1921), p. 7.
[1896] M.A.F. Mehren: Vues d'Avicenne; op cit; pp. 397-8.
[1897] P. Kraus: Les Controverses de Fakhr al-Din al-Razi; *Bulletin de l'Institut d'Egypte;* Vol 19 (1937); pp. 203-4.
[1898] Ibid.
[1899] Ibn Khaldun: *Muqaddima*; Fr. Tr. Vol 3; pp. 240-7.
[1900] Ibid; Fr. Tr. Vol 3; p. 245; Engl Tr. Vol 3; p. 262.

instruments, and once more, mounting an onslaught on Ptolemy's astronomy. Maslama (al-Majriti) (d.1007) wrote 'some chapters indispensable for everyone who wishes to construct an astrolabe,'.[1901] He also edited and adapted Al-Khwarizmi's tables to places in Spain.

Al-Zarqali (1029-1087) wrote two treatises on instruments, devised the Toledan Tables for the year 1080; and amended Ptolemy's exaggerated estimate of the length of the Mediterranean sea from 62^0 to nearer to its correct value of 42^0.[1902] Al-Zarqali is said to have found the movement of the solar apogee, which he held to be 1degree in 299 years, on the basis of twenty five years of observation.[1903] The motion of the solar apogee with reference to the stars, he said, amounted to 12.04" a year. He also gave a value of 77^0 50' for the longitude of the sun's apogee, and concluded that the inclination of the ecliptic oscillated between $23^0$33' and $23^0$53'.[1904] Al-Zarqali's *Tratado de la lamina de los siete planetas* is a predecessor to the Aequatorium planetarium of the Renaissance, and its Arabic text contains the clarification of one of the most debated passages of medieval astronomy.[1905] In the graphic representation included in the Castilian translation ordered by Alfonso the Wise, the orbit of mercury is not circular.[1906] On this basis, Al-Zarqali might have anticipated Kepler in stating that orbits (the orbit of Mercury in this case) are elliptical. Al-Zarqali treated Mercury in the same deductive way that Kepler dealt with Mars in his *Astronomia Nova*.[1907] The conclusion by Hartner is that 'it is not known whether Kepler knew of al-Zarqali's text,'[1908] which is somehow unfair on the Muslim scholar, for whilst Muslim scholars and scholarship are condemned for their borrowing from the Greeks, however faint the resemblance between the two, when it comes to later Western scientific findings, the same principle of resemblance is never applied, even when such resemblance between the Islamic and the Western is very obvious.

Jabir Ibn Aflah (d. 1150) is specially noted for his work on spherical trigonometry,[1909] a real step forward, including, for instance, a new

[1901] D.E. Smith: *History of Mathematics* (Dover Publications; New York; 1958), p. 192.
[1902] P.K. Hitti: *History,* op cit; p. 571.
[1903] J. North: *The Fontana History of Astronomy and Cosmology* (Fontana Press; London; 1994), p. 208.
[1904] B. Hetherington: *A Chronicle*; op cit; p. 120.
[1905] J. Vernet: Al-Zarqali: *Dictionary of Scientific Biography;* op cit; vol 14; pp. 592-5; at p. 594.
[1906] J. Millas Vallicrosa in J. Vernet: Al-Zarqali; p. 594.
[1907] J. Vernet: Al-Zarqali; op cit; p. 594.
[1908] See W. Hartner: *Oriens, Occidens* (Hildesheim; 1968), pp. 474-8; at p. 486.
[1909] W.M. Watt: *The Influence,* op cit, p. 35.

method of solving a right angled spherical triangle.[1910] Jabir has also been credited with the invention of the turquet,[1911] and other instruments. He devoted great effort to amend Ptolemy's theory of the planets. Lorch has examined this issue in detail.[1912] In the section on the sphericity of the heavens, Jabir describes Ptolemy's reasoning as, 'extremely compact and abbreviated-hence the worthlessness of the reasoning.'[1913]

The most famous of Jabir's criticisms concerns the position of Venus and Mercury. Ptolemy placed them between the Moon and the Sun, which thus divided the planets of limited elongation from those which could have any elongation. They have never eclipsed the Sun because they have never been in line with it-just as most conjunctions of Sun and Moon produce no eclipse. The question cannot be settled, Ptolemy says, because Venus and Mercury show no parallax, from which their distance from Earth could be measured, and placing them nearer the Sun would not entail any parallax even at their perigees.[1914] Jabir begins:

> 'I am very puzzled by what kind of man this is. I am quite at a loss to account for this inconsistency and confusion of his, which he did not notice. Such a thing must be very alien to anyone who makes any considerable study of these things, as he did. He did not see his inconsistency.'[1915]

Jabir then points out that Ptolemy himself had reckoned a maximum solar parallax at 2'51'', and that if Venus and Mercury were within the Sun's sphere, Venus would have a parallax of about a third of degree (the figure is almost exactly 19', actually) at its perigee and Mercury 7'. Jabir reasons that Venus' apogee must at best be the same distance from the Earth as the Sun's perigee, and scales up the parallax accordingly, a procedure that is accurate enough for such small angles. He is evidently considering Mercury as fitting beneath the Sun separately, for if he had calculated for both planets' being beneath the Sun (when Mercury's apogee is the same distance from the Earth as Venus' perigee), then Mercury's maximum parallax becomes just over 47'. Jabir considers it possible that the parallaxes he has calculated have not been observed, since to show them the planets would have to be in conjunction with the Sun. So he calculates the parallaxes for maximum elongation, 6' for Venus and 4' for Mercury

[1910] G. Sarton: *Introduction*; op cit; Vol II, p.123.
[1911] D.E. Smith: *History*; op cit; p. 206.
[1912] R.P. Lorch: The Astronomy of Jabir Ibn Aflah; *Centaurus*; XIX (1975), pp. 85-107.
[1913] Printed ed; pp. 48, 21, 1, 5960, etc; Ms Madrid 10006, ff 39 r, etc.. in R.P. Lorch: The Astronomy; p. 96.
[1914] R.P. Lorch: The Astronomy; p 97.
[1915] Printed ed; pp. 48, 21, 1, 5960, etc; Ms Madrid 10006, ff 39 r, etc.. in R.P. Lorch: The Astronomy; p. 97.

(actually, 7' and 4½' are better figures).[1916] The argument is brought to a triumphant climax:

> 'Since, therefore, no parallax worth bothering about (according to Ptolemy) is to be found in either of them, and the Sun does have a sensible parallax worth bothering about, how can they be below the Sun.?'[1917]

Al-Bitruji (d. c 1204), too, modified Ptolemy's system of planetary motions; but unlike Jabir, in his planetary theory, he positioned the Sun between Venus and Mercury.[1918] Al-Bitruji's *Kitab al-Haya*, is, according to Hetherington (who relies on MacKenzie and Sarton in his summing up):

> 'An attempt to revive in a modified form the theory of homocentric spheres: each heavenly body is attached to a sphere and the motive power is the ninth sphere outside the fixed stars. The prime mover produces in every sphere a motion from east to west; this motion is faster in the eighth sphere, and it decreases as the distance from the prime mover increases, e.g., the fixed stars complete a revolution in 24 hours, while the moon, which is carried by the innermost sphere, requires almost 25 hours for the same revolution. The pole of the ecliptic being different from that of the equator, the planetary orbits are not closed; moreover, the planets do not remain at an invariable distance from the pole of the ecliptic; each has its own motion in latitude, and a variable velocity in longitude. The eighth sphere has two motions, the one in longitude (precession), and another caused by the rotation of the pole of the ecliptic around a mean position (this is the imaginary trepidation of the equinoxes). The pole of each planet revolves around the pole of the ecliptic, each in its own way. His theory was called the theory of spiral motion.'[1919]

Kitab-al-Hay'ah' was translated by the Sicilian based Michael Scot under the title 'On the Sphere.' Its impact was strongly felt thereafter, the first author to be widely influenced being William of Auvergne, who endorses his system in his encyclopaedic work *De Universo*.[1920]

[1916] R.P. Lorch: The Astronomy; pp. 97-8.
[1917] Printed ed; pp. 48, 21, 1, 5960, etc; Ms Madrid 10006, ff 39 r, etc.. in R.P. Lorch: The Astronomy; pp. 97-8.
[1918] A. Djebbar: *Une Histoire*; op cit; p.194.
[1919] W. Mackenzie: *The Imperial Dictionary;* op cit; vol 1; p. 122; G. Sarton: *Introduction*; 2; 399; in B. Hetherington: *A Chronicle;* op cit; p. 146.
[1920] E.J. Dijksterhuis: *The Mechanisation of the World Picture* (Oxford at the Clarendon Press; 1961). p.212.

Muslims compiled a great numbers of zijs, that is astronomical handbooks with text and tables; in 1956, E.S. Kennedy publishing a survey of 125 such Islamic Zij;[1921] a number that has risen to close to 200, authored by names such as Al-Khwarizmi, al-Battani, al-Biruni, Ibn al-Banna (Marrakech fl. 1300).[1922] Most Zij consist of several hundred pages of text and tables; the treatment of the material presented varying from one zij to another, but most contain chapters and tables relating to the following aspects of mathematical astronomy:

1: Chronology.
2: Trigonometry
3: Spherical astronomy
4: Planetary means motions
5: Planetary equations
6: Planetary latitudes
7: Planetary stations
8: Parallax
9: Solar and Lunar eclipses
10: Planetary and lunar visibility
11: Mathematical geography (lists of cities with geographical coordinates)
12: Uranometry (tables of fixed stars with coordinates)
13: Astrology.[1923]

Mathematical astronomy is concerned with the determination of the position of the sun, the moon, planets and fixed stars; the prediction of planetary conjunctions, eclipses, visibility of lunar crescent, time keeping by the sun and the stars etc. King informs us that the science has a long Yemeni tradition, from the 10th century until the present; with about one hundred manuscripts dating from the medieval period that have survived.[1924] Like the rest of Muslim works in other sciences, they can be found scattered in libraries across the world. The Yemeni works on astronomy are very precious not just in their own right, but also because they include material from sources since lost. Each year, almanacs and ephemerids were prepared for the Yemeni sultans by their astronomers that included tables of the position of the sun, moon, and planets for each

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[1921] E.S. Kennedy: A Survey of Islamic astronomical Tables; pp. 123-77 in D. A. King: Astronomy, in *Religion, Learning and Science (*M.J.L. Young; et al ed), op cit; pp. 274-289; at p.276.
[1922] D. A. King: Astronomy; p.276.
[1923] Ibid; p.277.
[1924] D.A. King: Mathematical Astronomy in medieval Yemen, in *Arabian Studies*; Vol 5; pp 61-65.

day of the year. Two manuscripts on these subjects survive. The first Yemeni astronomer about whom there is reliable information is Al-Hamdani, who compiled a Zij. The second, Abu'l-Uqul worked for Sultan al-Mu'ayyad, and compiled a Zij based on the works of Ibn Yunus, which can no longer be found; this Yemeni work salvaging what would otherwise have been lost.[1925] Abu'l-Uqul's contribution was also to prepare tables for time-keeping by the Sun and the stars for the latitude of Ta'iz; a corpus that is the largest known for any medieval Islamic city, containing over one hundred thousand entries.[1926] Yemeni rulers had their contributions, too, including Sultan al-Muzaffar, who sponsored two astronomers, al-Farisi and al-Kawashi. The first prepared a Zij containing tables for the Yemen, whilst the second prepared a Zij with tables specifically for Aden and Ta'izz. Sultan al-Ashraf, for his part, compiled a treatise on the construction of astrolabes and sundials, and also prepared new tables of coordinates for drawing the curves on astrolabe plates and the curves on horizontal sundials, computing these tables for the latitudes of the major centres of the Yemen and the Hijaz.[1927] One of the astrolabes made by al-Ashraf is now at the Metropolitan Museum of Art in New York; but more crucially, as noted by King, al-Ashraf's treatise contains in the appendix a discussion on the magnetic compass.[1928] Like al-Ashraf, Sultan al-Afdal compiled an extensive compendium of astronomical treatises and tables, derived from various sources, now lost. And so were the works of the early Yemeni astronomers, with the exception of those few that survive scattered in the libraries of the world.

Whether east or west of the Islamic land, the mid-late 13th century brought a sharp decline in astronomical writing. In the West this followed the loss of Muslim Spain; in the East, this was due to the crusader-Mongol onslaught. The activity of worth east of Egypt was represented by the Maragha observatory, whose erection was due not to Mongol scientific investigation, but rather to their leader Hulagu's reliance on the stars for the conduct of his wars against the Muslims.[1929] At his service was the astrologer Nasir Eddin Al-Tusi (b.1201), who advised him on the onslaught against Baghdad in 1258.[1930] There, subsequently, nearly a

[1925] Ibid; p. 63.
[1926] Ibid.
[1927] Ibid; pp. 62-3.
[1928] Ibid; p. 63.
[1929] Baron G. D'Ohsson: *Histoire des Mongols,* op cit, vol 3; pp. 224 ff.
[1930] Ibid; pp. 225-6.

million lives were wiped out.[1931] Al-Tusi was put in charge of the said observatory, which enabled him to prepare the Il-Khani Tables, a catalogue of fixed stars, and prepare a treatise on the Quadrilateral,[1932] a work on spherical trigonometry.[1933] In the same environment Ibn al-Shatir, al-Urdi, and Muhi Eddin al-Maghribi also worked. Al Urdi (d. 1266) of Aleppo was the first to initiate the construction of planetary models, besides constructing other instruments, detailed in his *The Instruments of the Observatory of Maragha*.[1934] Ibn al-Shatir is widely held to have been at the source of the planetary theory devised centuries later by Copernicus.[1935]

In the final decades of the 13th century, Mamluk Egypt had probably the best contribution to astronomy of this later period. Amongst its astronomers was Al-Marrakushi, who was of Moroccan origin but who worked in Cairo. He wrote *Kitab al-mabadi wa'l ghayat fi ilm al-Miqat* (A Compendium of Astronomical Time Keeping), a complete survey of spherical astronomy and astronomical instruments.[1936] Shihab Eddin al-Maqsi, who flourished in Cairo, compiled a treatise on sundial theory, and a set of tables for time-keeping.[1937] Najm Eddin al-Misri, also flourished in Cairo, and compiled a table for time keeping that could be used not only for all latitudes but also for time keeping by the Sun by day and by the stars by night.[1938]

After the 13th century, just as with every other science, astronomical output dwindled considerably. Al-Kashi and his fellow members of the Samarqand observatory, to be considered further on, being the authors of a final flowering of Islamic astronomy (and mathematics). Other later figures include Ibn Qunfudh (d.1407), an Algerian historian, mathematician and astronomer, who wrote '*Help to the Students for the Determination of the Positions of the Planets*.'[1939] In 1475, Al-Suyuti of

[1931] 800, 000 people according to H.H. Howorth: *History of the Mongols* (London, 1927), in Y. Courbage and Fargues: *Chretiens;* op cit; p. 29.
[1932] Edited with French translation by Caratheodory Pasha (Constantinople, 1891).
[1933] Baron Carra de Vaux: Astronomy, op cit, p. 396.
[1934] World Who's Who in B. Hetherington: *A Chronicle*; op cit; p.40.
[1935] On this, see:
-N. Swerdlow-O.Neugebauer: *Mathematical Astronomy in Copernicus "De revolutionibus"* (New York, Springer Verlag, 1984).
G. Saliba at: http://www.columbia.edu/~gas1/project/visions/case1/sci.1.html
[1936] D.A. King: The Astronomy of the Mamluks; *ISIS*; 74 (1983), 531-55; p.539.
[1937] Ibid; p. 540.
[1938] Ibid.
[1939] World Who's Who in Science; Chicago; 1968; in B. Hetherington: *A Chronicle*; op cit; p. 188.

Cairo compiled a treatise on the references to astronomy in the Qur'an.[1940] In 1480, Cyriacus wrote a zij entitled *Durr al-Muntakhab* (The Chosen Pearl), calculated for the city of Mardin in south-east modern Turkey; with one set of planetary tables, about 10,000 values for each planet, and instructions on how to determine the position of any planet at any time using only addition.[1941] The Moroccan astronomer al-Rudani (1623-83) was probably the last Islamic astronomer of any worth. He invented a spherical engine, which functioned within shells, that was used to measure time, and that could be operated at any longitude or latitude.[1942]

3. Instruments:[1943]

The use of instruments made it possible to reach precise calculations, and also resolve first hand astronomical problems. Precision, from the early stages of Islamic civilisation occupying the highest concern of Islamic scholars. Thabit Ibn Qurra (b.826), for instance, stated that pure Greek reasoning cannot always match observation in accuracy, declaring 'What is perceived by sense does not lend itself to such precision.'[1944] His own treatise on sundial theory contains all the necessary mathematical theory for the construction of sundials in any plane.[1945] Such instruments resolved what were hitherto complicated or insoluble problems. The quadrant, for instance, of which are three varieties, such as the sine quadrant were described by al-Khwarizmi, was widely used throughout the Islamic world to solve problems of spherical astronomy for any latitude.[1946] These instruments varied from the handy astrolabe to the very bulky ones used in observatories.

[1940] D. A. King: The Astronomy of the Mamluks; op cit; at p. 549.
[1941] G. Saliba: The Double Argument Lunar Tables of Cyriacus; *Journal of History of Astronomy*; 7; (1976), pp. 41-6; at p.41.
[1942] M. A Kettani: Science and Technology, op cit, p. 77.
[1943] The best source on this subject still remains: L. Sedillot: Memoire sur les instruments astronomique des Arabes, *Memoires de l'Academie Royale des Inscriptions et Belles Lettres de l'Institut de France* 1: 1-229 (Reprinted Frankfurt, 1985).
[1944] In R. Morelon: Eastern Arabic; op cit, p. 46.
[1945] D.A .King: Astronomical instruments in the Islamic World; in *Encyclopaedia* (Selin ed); op cit; pp. 86-8; p. 88.
[1946] Ibid; p. 87.

The astrolabe is one of the earliest instruments the Muslims developed and perfected. It is a flat and circular instrument, with, in the centre, a disc engraved with indicator lines whose positions are worked out mathematically; the disc rotating in a holder, one side of which has a fret of thin pieces of brass ending in points that represented the stars.[1947] By rotating the inner disc it is possible to find rising and setting times for the celestial bodies, and to determine the occurrence of other astronomical events, which hence makes the astrolabe a graphical computer.[1948] For Williams, the astrolabe was the most important astronomical calculating device before the invention of digital computers, and the most important astronomical observational device before the invention of the telescope.[1949] The oldest astrolabe in the History of Science Museum at Oxford was made about 950.[1950]

The uses of the astrolabe seem limitless.[1951] Al-Khwarizmi claimed that the astrolabe could solve 43 problems, whilst Al-Sufi claimed that with it he could answer a thousand astronomical questions.[1952] Within the limits of their definitions of problems and questions, Saunders points out, both were probably correct.[1953] Thanks to the astrolabe, it was possible to calculate the altitude and azimuth of the sun, the moon, stars and planets; time; and to measure distances and heights.[1954] The astrolabe was used in astronomy, of course, but also in other areas such as surveying, navigation, and so on.[1955] Some such other usages will be touched upon as this work progresses. Extremely precise, it was capable of measuring the altitude of the sun or the stars to an accuracy of about one degree.[1956] An instrument of this kind, Pedersen explains had never been at the disposal of Latin astronomers,[1957] and once it was introduced in Europe (very likely the early 11th century, though its first known use dates from later in the

[1947] C. A. Ronan: The Arabian; op cit; at p. 208.
[1948] Ibid.
[1949] Montgomery College's Planetarium home page. Web page by H. Alden Williams.
[1950] H.N. Saunders: *The Astrolabe* (Brunswick Press Ltd; Teignmouth; UK; 1971), p.8.
[1951] See: W. Hartner, ''The Principle and use of the astrolabe," in W. Hartner, *Oriens-Occidens*, op cit; pp. 287-318; and J.D. North: ''The Astrolabe," *Scientific American* 230, No 1, 1974, pp 96-106.
[1952] H.N. Saunders: *The Astrolabe*; op cit; p.7.
[1953] Ibid.
[1954] C. Ronan: The Arabian Science, op cit; p.209.
[1955] See: W. Hartner, 'The Principle; op cit; pp. 287-318; and J. D. North: ''The Astrolabe," op cit; pp 96-106.
[1956] O. Pedersen: 'Astronomy' in *Science in the Middle Ages*; David C. Lindberg ed (The University of Chicago Press. Chicago and London. 1978), pp 303-37 at p. 309.
[1957] Ibid.

century, with Walcher of Malvern),[1958] it made it possible to measure celestial phenomena, and express them very accurately.[1959]
Krisciunas elaborates on an astronomical use of the astrolabe. He explains that the sighting device, usually to be found on the back of the astrolabe, is called the alidade, from the Arabic *al-idadah* (turning radius). It is a straight edge which points to degree markings around the edge while it turns about the centre of the astrolabe. The alidade has a sight at each end made up of a flat piece of metal with a small hole (about 2mm) drilled through. One hangs the instrument from a finger of one hand and rotates the alidade until one can sight a known star through the two holes. In the case of the sun one would cast the round image of the sun through the top hole on to the lower sighting hole. One then simply reads off the elevation angle from the outside edge of the back of the astrolabe. Then, on the front of the astrolabe, one rotates the rete to place the star or Sun at the correct elevation angle in the eastern or western half of the climate. It is then possible to determine the elevation angles and azimuths of all the other stars represented in the rete (without any calculating whatsoever), determine the local sideral time (the right ascension corresponding to the meridian), or to determine the local solar time. Then, using one's known geographical longitude and a graph of the equation of time (the difference between mean and apparent solar time) it is possible to derive the modern standard time (e.g Greenwich Mean Time).[1960]

Muslim makers of astrolabes have attracted the attention of Mayer, who described over a hundred of them, their works, the places and date the astrolabes were made, and gives a first class bibliography as well.[1961] Mayer also gives the present locations of such astrolabes, and when appropriate, their owners. Because astrolabes were the first scientific instruments in history, sophisticated and elegantly presented, he points out, it makes access to them very difficult. These astrolabes are dispersed all over the world. Ibrahim B. Sa'id (fl 11th century) of Valencia constructed many astrolabes, one of which being part of a Spanish collection, is now in the Lewis Evans Collection in the Museum of the History of Science, Oxford; another can be found in the Museo

[1958] C. Burnett: The Introduction of Arabic learning into British schools in *The Introduction of Arabic Philosophy into Europe*; C.E. Butterworth and B.A Kessel ed (Brill; Leiden; 1994), pp. 40-57; pp 44.
[1959] O. Pedersen: Astronomy; op cit; p. 309.
[1960] K. Krisciunas: *Astronomical Centers of the World* (Cambridge University Press; 1988), Pp.36-8.
[1961] L.A. Mayer: *Islamic Astrolabists and Their Works* (Albert Kundig; Geneva; 1956).

Astronomico, Rome, (N 688), and a few more scattered elsewhere.[1962] Amongst those made by Mohammad b. Fattuh of Seville (early 13th), is an *azaphea (safiha)* now in the Osservatorio Astronomico Rome (no 694ii); another in the Bibliotheque Nationale, Paris, and another in the Adler Planetarium, Chicago.[1963] An astrolabe built by Abu Bakr B. Yusuf Marrakech (13th century) is now at the observatory of Strasbourg; another was once held in a Dominican monastery in Toulouse, and another was in the possession of Baron de Larrey. One of the earliest astrolabes still extant was made by Khalif in the 9th century. It was formerly at the Landau collection, Paris, before it was moved to the Billmeir collection in London.[1964] Even earlier than Khalif was Ahmad b. Khalaf, who made an astrolabe for Caliph Ja'far b. Muktafi Billah, formerly in the Barbier collection, then moved to the Bibliotheque Nationale, Paris.[1965]

Makers of astrolabes frequently wrote on the subject, too. Al-Zarqali of Toledo, (b.1029) wrote *al-Safiha al-Zarqaliya* (Azafea), a treatise on the universal astrolabe, invented by him. It was a stereographic projection for the terrestrial equator and could be used to solve problems of spherical astronomy for any latitude.[1966] It was derived from the universal astrolabe of al-Shakkaz, and includes a table of 29 stars with ecliptical coordinates intended to be marked on the instrument.[1967] Ibn al-Samh (11th century), who flourished at Grenada, wrote two treatises on the use and construction of the astrolabe, besides compiling astronomical tables.[1968] Before him, and most certainly the first Western Muslim to write on the instrument, was Al-Majriti (d.1007) who wrote 'some chapters indispensable for everyone who wishes to construct an astrolabe,' which includes a table of 21 stars entitled *Table of the Places of the Fixed Stars...*[1969] Al-Farghani's treatise on the same subject explained the mathematical theory behind the instrument and corrected the faulty geometrical constructions of the central disc that were current then.[1970] Al-Badi al-Asturlabi (d. 1140), who at some point was a director of observations in the palace of the Seljuk sultan Mughith al-Din Mahmud, was, according to Sarton, the greatest

[1962] Ibid; pp.50-2.
[1963] Ibid; pp. 64-6.
[1964] Ibid; p. 54.
[1965] Ibid; p. 37.
[1966] D.A. King: The Astronomy of the Mamluks; op cit; p. 533.
[1967] P. Kunitzsch: Two star tables from Muslim Spain; *Journal of History of Astronomy*; Vol 11 (1980), pp 192-201; at p. 192.
[1968] G. Sarton: *Introduction;* op cit; 1; 715.
[1969] D.E. Smith: *History*; op cit; p.192.
[1970] C. Ronan: The Arabian; op cit; p. 207.

expert of his time in the knowledge and construction of astrolabes,[1971] hence his name. Al-Nairizi (who also compiled astronomical tables) and Qusta ibn Luqqa are two other writers on the subject.[1972] Fewer writings on the subject appeared after 13th century, and they include those by Al-Muwaquit (d.1336),[1973] and the Moroccan Al-Jazuli (fl. 1344).[1974]

A great number of other astronomical instruments were constructed and written about by Muslims, of which the following is only a brief outline, Sedillot, noted above, providing the best data and sources for the subject. Jabir Ibn Sinan (fl early 9th century) constructed astronomical instruments.[1975] Amongst the instruments that can be cited is the gnomon used for measuring altitudes of the sun and other planets; the celestial sphere to explain celestial movements, and the sundial for calculating the time of day and the azimuth (compass bearing).[1976] Al-Khujandi (d. 1000) constructed an instrument *al-Suds al-Fakhri* (sixth of a circle) for the measurement of the ecliptic.[1977] Al-Khujandi states that with this instrument degrees, minutes and seconds could be measured, whereas before him, instruments did not indicate seconds.[1978] For the observation of the planets, al-Khujandi constructed an armillary sphere and other instruments, besides a universal instrument called *al-Ala al-Shamila* (Comprehensive Instrument), which was used instead of the astrolabe or the quadrant, and that could be used for any latitude.[1979] Ibn Baja (b.1106) constructed a planetary system based on eccentric circles but not epicycles,[1980] whilst Jabir ibn Aflah (d.1150), already cited for his Turquet, designed a portable celestial sphere to measure and explain the movements of celestial objects.[1981] Al-Khazini, (fl 1115), famed for his Balance of Wisdom (more on this further on) described the construction of a 24 h water clock designed for astronomical purposes.[1982] More

[1971] G. Sarton: *Introduction*; op cit; vol 2; p. 204.
[1972] Ibid, vol I, p.585:
[1973] Ibid; vol 3; p.696.
[1974] Ibid; p.695.
[1975] G. Sarton: *Introduction*; vol I, op cit; p. 585
[1976] A. Buang: Geography in the Islamic world; in *Encyclopaedia* (Selin ed): pp 354-6: at p.356:
[1977] S. Tekeli: Al-Khujandi; *Dictionary of Scientific Biography;* op cit; pp. 352-4; at p. 353.
[1978] Ibid.
[1979] Ibid.
[1980] J.L.E. Dreyer: A History; op cit; p.262.
[1981] R.P. Lorch: The Astronomical Instruments of Jabir Ibn Aflah and the Torquetom; *Centaurus* (1976), vol 20; pp 11-34.
[1982] R.P. Lorch: Al-Khazini's Balance Clock; in *Archives Internationales d'Histoire des Sciences*; Vol 31 (1981), pp. 183-9; at p. 183.

importantly, Al-Khazini is the author of a treatise on instruments *Risala fi'l Alat*, which has seven parts, each of which was devoted to a different instrument: a triquetrum; a dioptra; a 'Triangular instrument;' a quadrant; devices involving reflection; an astrolabe; and simple aids for the naked eye; the quadrant is in fact called a suds, or sextant, and performs the functions of the sextant, although its arc is 90^0.[1983] Apart from describing the devices and their use, the treatise also demonstrates their geometrical basis.[1984] A great number of sundials were made, including those by Al Mursi (d. 1315),[1985] and Ibn Basa (d.1316), who also improved and simplified the Azafea of Al-Zarqali so that it could serve any latitude with a single tablet.[1986] Al-Mizi (b.1291) constructed quadrants and also wrote treatises on their construction, whilst Ibn Sarraj (fl 1325) developed several varieties of markings for the almucantar quadrant, besides devising various highly ingenious trigonometric grids as alternatives to the simple sine quadrant.[1987] Ibn al-Majdi (b.1358) wrote *Khulasat al-Awqal*, which explains the use of the sine quadrant; and *Risala fi-l-Amal bi rub al-Muqantarat al-maqtu* a treatise on the use of a quadrant bearing projections of almuncatars or parallels of altitude; and also a treatise on sundial theory.[1988] Al-Maradini (fl.1400) in Damascus, and later in Cairo, devised a universal quadrant, consisting of two shakkaziya quadrants of the same size attached at their centres, and designed to solve a given problem in spherical astronomy by transferring the problem to a plane stereographic projection of the celestial sphere.[1989]

Possibly the last greatest writer/maker of instruments in Islamic civilisation was Al-Kashi. In 1416 he composed the short *Risala dar shar ialat I rasd* (Treatise on Observational Instruments) dedicated to the Turkish sultan Iskander.[1990] In this work al-Kashi describes the construction of eight astronomical instruments: Triquetrum; armillary sphere; equinoctial ring; double ring; fakhri sextant, an instrument 'having azimuth and altitude,' an instrument 'having the sine and arrow,' and a small armillary sphere.[1991] At about the same time he completed *Nuzha al-*

[1983] R.E. Hall: Al-Khazini: *Dictionary of Scientific Biography;* op cit; vol 7; pp. 335-58; at p. 338.
[1984] Ibid.
[1985] G. Sarton: *Introduction;* vol 3; op cit; p.695.
[1986] Ibid; p.696.
[1987] D.A. King: The Astronomy of the Mamluks; op cit; p.544.
[1988] Ibid.
[1989] Ibid; p.548.
[1990] A.P. Youschkevitch; B.A. Rosenfeld: Al-Kashi; *Dictionary of Scientific Biography*; vol; 7; pp. 255-62. at p. 255.
[1991] Ibid; p. 259.

Hadaiq (The Garden Excursion), which he further revised upwards in 1426 at Samarkand (Samarqand).[1992] In this work he describes the 'Plate of Heavens' an astronomical instrument he invented, and also describes the plate of conjunctions.[1993] The first plate (of heavens) is a planetary equatorium and is used for the determination of the ecliptic latitudes and longitudes of planets, their distances from the earth, and their stations and retrogations; like the astrolabe, which it resembles in shape, it was used for measurements and for graphical solutions of problems of planetary motions by means of a kind of monogram; the second instrument is a simple device for performing a linear interpolation.[1994] Subsequently, a well known illustration from a 16th century Ottoman Turkish manuscript, now in Istanbul, shows a large bronze armillary instrument of observation with a supporting frame constructed entirely in wood.[1995] As drawn, North observes, the complete instrument would have been nearly five times the height of the men shown using it.[1996]

Celestial globes have occupied a leading place in Islamic interest. Amongst their makers are Ibrahim ibn Said al-Wazoon and his son Mohammed, who in 1081 built in Valencia a metal celestial globe that was 209 mm in diameter, which represented the celestial sphere as given by Ptolemy, but with increases to the longitudes of all the stars; and the names of the constellations in Arabic Kufic characters.[1997] Qaysar (1178-1251) born at Asfun, Upper Egypt; astronomer, mathematician, and engineer, built in 1225 the second oldest existing Arabic celestial globe.[1998] Sarton points out that the five oldest are by the Muslims,[1999] and are kept as follows:

1) In Firenze (constructed in Valencia by al-Sahli in 1080-1).
2) One kept in Naples (constructed in 1225-6 by Qaysar).
3) One kept in London (constructed in 1275/6 by Muhammad b. Hilal of Mosul.)
4) That of al-Urdi (constructed in 1279 or 1289, kept in Dresden.)
5) A fifth which is not dated, but possibly anterior to one or many of those listed (kept in the Bibliotheque Nationale of Paris.)[2000]

[1992] Ibid; p. 255.
[1993] Ibid; p. 260.
[1994] Ibid.
[1995] J. North: *The Fontana History of Astronomy;* op cit; p. 201.
[1996] Ibid.
[1997] Meucci: Arabian celestial Globe; in B. Hetherington: *A Chronicle*; op cit; p.127.
[1998] G. Sarton: *Introduction;* op cit; vol 2; p.623.
[1999] Ibid.
[2000] Noted by A. Mieli: *La Science Arabe;* op cit; p.154.

Emilie Savage Smith's work on celestial globes is by far the most instructive of all on the subject.[2001] The problem lies with the author's using the expression 'Islamicate' to refer to Islamic, which is quite deprecating of the Islamic role; an attitude constantly reinforced (turning into a rant in places) by assertions such as found in the foreword (p.iv): 'the production of scientific instruments derived from the Greco Roman tradition in the Islamic world.' Then, in the first lines of the Abstract (p. ii), she insists again: on the 'references in classical Greek and Roman literature to earlier globes that are no longer extant.' Then, again, in page vi of the preface she uses the term: 'Islamicate instead of Islamic' because, she argues:

> 'It can be used to refer to objects or cultural features that are not directly related to the religion but are often based on traditions taken from other cultures and nurtured and developed by Muslims and non Muslims alike.... These globes represent a tradition of instrument design inherited from the Hellenistic, Roman, and Byzantine worlds..'

To Smith's insistence on this point, can be counter argued that there is no concrete evidence of any globe from the Greek world. After all, Byzantium only fell in 1453. If the Greeks had made them, they would have been found there. Islamic celestial globes date from centuries earlier than that, and can still be traced. Besides, there is no reference from any witness of Greco-Roman globes in Byzantium, or any other part of the Latin-Greek world. And the Muslims, just as with other objects or works, would have mentioned them had they seen them. Where Smith is absolutely right, though (p.vi), is the wish to see more celestial globes now in small museums and private collections come to light and be made available for study to help provide a fuller picture of the development of the design and construction techniques.

More importantly, as Savage Smith points out, from early in the 12th century, probably before 1120, we have a fascinating treatise on 'the Sphere that rotates by itself' by Al-Khazini, who later dedicated some other astronomical writings to the Seljuk ruler, Sanjar Ibn Malik (1097 to 1157). This treatise, which has been recently edited and translated (by Lorch in 1980),[2002] describes a celestial globe which, instead of being placed in the usual set of rings, is half sunk in a box and propelled so as to

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[2001] E. S. Smith: *Islamicate Celestial Globes* (Smithsonian Institute Press; Washington, D.C, 1985).
[2002] R. Lorch: Al-Khazini's sphere that rotates by itself; *Journal for the History of Arabic Science* (1980), 4; pp. 287-329.

rotate once a day by a mechanism of pulleys driven by a weight resting on top of a reservoir of sinking sand.[2003] This sphere
'Is set halfway into a box whose upper surface serves to mark the horizon. Over the sphere, along the north south line, was affixed a half circle of brass, which served as a meridian ring, with the axis of the globe set at the south pole inside the box and the north pole at a hole in the meridian ring corresponding to the geographical latitude of Merw. The rest of the box covered the top of the mechanism, which automatically rotated the sphere one rotation per day. The equator was inscribed on the globe and divided into 360 equal parts. Taking as a pole a point 23 degree 35 minutes measured along the meridian ring from the pole of the equator, the ecliptic was inscribed and divided into zodiacal houses and degrees. Al-Khazini then indicated a circle on the surface of the box around the globe, which he also divided into 360 degrees, and on which he named the four points of the compass, so as to serve as the horizon ring.'[2004]
The value of this object can never be overestimated.

4. Observatories:

The established wisdom holds that observatories are a late invention of Europe.[2005] Those who recognise the Islamic origins of observatories, still consider them a late and a short-lived institution.[2006] Here follows evidence proving both positions wrong.

Sedillot insists that the observatory as a distinct scientific institution for observation, and where astronomy and allied subjects were taught, owes its origin to Islam.[2007] Sayili, in his ground breaking work, also demonstrates that the observatory as a scientific, specialised institution, is owed to Islam.[2008] These views are correct as they fit within the pattern already observed in relation to many breakthroughs, i.e the close ties

[2003] E. Savage Smith: *Islamicate;* op cit; p.25.
[2004] Ibid.
[2005] A view vulgarised for the general public as on 10 August 1999, on BBC2.
[2006] I.e: T.E. Huff: *The Rise of Early Modern Science* (Cambridge University Press, 1993), pp. 179-80.
[2007] L.A. Sedillot: Prolegomenes des tables Astronomiques d'Ouloug -Beg, texte, *Chrestomathie Persane*, vol 1 (1847), p. CVII.
[2008] A Sayili: *The Observatory*, op cit.

between science and observance of the faith, between the spiritual and the practical.[2009] On the spiritual side, the zeal to contemplate and observe God's creation, and the urge to understand its vastness, as found and stipulated in the Qur'an, and as expressed by nearly all Muslim astronomers, was a major reason for observation and study of the planets. The Qur'an in sura 50, verse 6 says:

> "Do they not look at the sky above them, how We have built it and adorned it, and there are no rifts in it."

sura 31, verse 10 says:

> "(God) created the heavens without any pillars that you can see..."

On the practical side, in observing their religious practices Muslims came across problems they had to resolve.[2010] This entailed, for instance, accuracy in the observation of the planets so as to determine many religious matters, the emphasis on precise results being such that theologians saw it was necessary to be involved in observations.[2011] This emphasis, in turn, led to a greater role for patronage of astronomy, the use of precise instruments, and also the need for organised teams of scholars, involved in diverse sciences (geometry, arithmetic, instrument designers, etc) working together, making observations in groups, and checking each others' observations.[2012] Hence, out of necessity, the observatory and observation became established within Islam.

The earliest date generally agreed upon for the erection of observatories is the 9th century, when state run observatories were established simultaneously in Baghdad and Damascus. Prior to this, astronomers used their homes for the purpose of observation. Al-Hassan of Baghdad (fl.825) (known for his book on the measurement of the sphere) was one of the earliest to build an astronomical observatory in his home.[2013] He was one of the three Banu Musa brothers, who made observations from their house located on the Tigris River. They studied The Ursa Major (or the Great Bear), measured maximum and minimum altitudes of the sun, and made observations of lunar eclipses.[2014] The Banu Musa also made observations at Samarra,[2015] and they apparently arranged for simultaneous observations of a lunar eclipse in Samarra and Nishapur in order to

[2009] Ibid, p.4.
[2010] M. Hoskin and O. Gingerich: Islamic Astronomy; op cit; pp. 52-7.
[2011] A Sayili: *The Observator*, op cit; p. 26.
[2012] Ibid; pp. 25-31.
[2013] World Who's Who, in B. Hetherington: *A Chronicle*; op cit; p.92.
[2014] In L.A. Sedillot: *Histoire generale des Arabes*, 2 Vols (Paris, 1877), vol 2, p. 11.
[2015] Al-Biruni: *Tahdid Nihayat al-Amaqin li tashih Masafat al-Masakin;* Istanbul; Sulaymaniye Library; Fatih-3386; p. 84.

determine their difference of longitude.[2016] One of their Samarra observations was that of an autumnal equinox.[2017] From a statement concerning their measurement of a meridian height of the sun, wherein the expression 'observation in both circles' occurs, Shoy guesses that they may have used an armillary sphere, or perhaps solsticial and equinoctial armillas.[2018]

Ibn Sina, Al-Battani, Al-Farghani also had their own home based observatories. Al-Battani's observatory was located in Raqqa, from where he made observations covering forty years (887 to 918), whilst Ibn Sina's observatory was in Hamadan. Ibn Sina and al-Biruni were preoccupied with increasing the precision of the instruments: Ibn Sina invented a device in principle equivalent to the micrometer,[2019] whilst Al-Biruni provided what was to be a forerunner of the method of transversals.[2020]

The first observatory, in the truer sense, was at Shamsiyah (Baghdad), set up by Caliph Al-Mamun around 828-829. It was associated with the scientific academy of *Bayt al-Hikma* (House of Wisdom) (also set up by Al-Mamun.) Simultaneously another observatory was set up on the outskirts of Damascus on Mount Qasiyun.[2021] Al-Biruni mentions an observation of autumnal equinox made at Qasiyun, in connection with which a comparison seems to have been made with Baghdad on the basis of an eight degree value for the difference of longitude between the two cities.[2022] Shamsiyah was headed by Ibn Al-Naubakht and Al-Khwarizmi, whilst at Damascus, one of the superintendents was Abu Mansur (b. 885).[2023] The ablest astronomers of the era were brought together at the expense of the sovereign, charged most particularly with proving the data in Ptolemy's Almagest, and of making observations of the Sun and the Moon for one year.[2024] Amongst such astronomers were Al-Jauhari and Yahia B. Abi Mansur. Al-Jauhari (fl. 830) participated in the astronomical observations made in Baghdad (829-30) and Damascus (832-3), and was

[2016] Al-Biruni: *Tahdid Nihayat al-Amaqin*; p. 287.
[2017] Ibid, p. 337.
[2018] C. Shoy: Die Bestimmung der Geographischen…. In *Annalen der Hydrographie und Maritimen Meteorologie* (1922) Vol 50; p.11.
[2019] E. Wiedemann: *Uber ein von Ibn Sina Hergestelltes Bobachtungsinstrument, Zeitschrift fur Instrumentenkunde* (1925), pp 270-1 ff.
[2020] F.Schmidt: *Geschichte der Geodatischen Instrumenten und Verfahren in Altertum und Mittelalter*, (1935), pp. 26, 266, 280.
[2021] A.L. Sedillot: *Histoire generale des Arabes*, op cit; p. 8.
[2022] Al-Biruni: *Tahdid Nihayat al-Amaqin*; op cit; p. 78.
[2023] B. Hetherington: *A Chronicle*; op cit; p.101.
[2024] F. Micheau: The Scientific Institutions in the Medieval Near East, in *Encyclopaedia* (Rashed ed) op cit; vol 3, pp. 985-1007; p. 993.

in charge of the construction of astronomical instruments, as well as being the author of the *Kitab al-Zij* (Book of Astronomical Tables), based on the observations made in Baghdad.[2025] Habash al-Hasib tells how Caliph al-Mamun ordered Khalid al-Marwrudhi, another astronomer involved, to make ready instruments of the greatest possible perfection, and to observe the heavenly bodies for a whole year, which Khalid did, 'thus attaining to the truth concerning the position of the sun and the moon across the heavens, and when this was done, Al-Mamun ordered the preparation of a canon containing all this material for those desirous of learning that science.'[2026] In both Baghdad and Damascus observations were made of the Sun, the Moon and planets, and results were presented in a new set of tables, or Zij, known as the Ma'muni or Mumtahan (tested) Zij.[2027] Work was done on the solar year, the obliquity, the eccentricity of the orbit of the sun, and on the location of its apogee.[2028] Observation resulted in the discovery of the movement of the solar apogee, while the equinox observations led a pretty exact value for the length of the solar year.[2029] Observations, which gave new values for the inclination of the ecliptic at $23^0 33'$,[2030] the position of the solar apogee at $82^0 39'$,[2031] and addressed problems such as the rate of equinoctial precession, the mean motions of the sun, the moon and the planets and so on.[2032] The precession was found to be one degree in sixty years and eight months.[2033] Following the time of Al-Mamun, in good Islamic tradition, the Banu Musa Brothers, Habash, Al-Nayziri and al-Mahani all checked the value of this constant through their observations.[2034]

Making these observations possible, and yielding such results is largely due to the fact that at this early stage, already, large instruments were introduced. In this respect, Hartner corrects the prevailing view such as held by Neugebauer that colossal observational instruments were only

[2025] A.I. Sabra: AL-Jauhari; *Dictionary of Scientific Biography;* op cit; vol VII; pp. 78-80.
[2026] A. Sayili: The Introductory section of Habash's Astronomical Tables; op cit; pp. 150; 142-3.
[2027] A. I. Sabra: The Scientific Enterprise; op cit; pp 186-187.
[2028] Ibn Said al-Andalusi: *Tabaqat al-Umam;* ed. L. Cheikho (Beirut; 1912), Fr Tr. R. Blachere (Paris; 1935), Hadji Khalifa: *Kashf al-Zunun*; ed. Flugel; 7 vols (1835-1858), in A. Sayili: The *Observatory;* op cit; p. 77.
[2029] L.A. Sedillot: *Tables Astronomiques d'Oulouh Beg;* vol 1 (Paris; 1839), pp. 43-4.
[2030] J.L.E. Dreyer: *A History;* op cit; p. 246.
[2031] W. Hartner: The Role; op cit; p. 8.
[2032] A. I. Sabra: The Scientific enterprise; op cit; p.187.
[2033] J. Greaves: *Astronomica Quaedam ex Traditione Shah Cholgii Persae* (London; 1652), p. 29.
[2034] Ibn Yunus: *Kitab al-Zij;* ed. And trans Caussin; vol 7 (1803), pp. 164-7.

known at the end of Islamic civilisation (14th-15th century).[2035] Such instruments, Hartner insists, were already in use in both Baghdad and Damascus.[2036] Al-Biruni, for instance, speaks of a quadrant that had an inner radius(?) of about five meters; that was made of marble and had an accessory part sliding over its arc, with a hole, through which one looked at the Sun and the spike located at the centre of the quadrant.[2037] Montucla mentions a 52 foot instrument used in Damascus, which he guesses to be a gnomon.[2038]
Another major breakthrough is the length of time devoted to observation from any one place. The Amajurs, thus, performed observations which stretched over nearly fifty years, including observations of fixed stars, as well as lunar, solar, and planetary observations, which resulted in the preparation of several astronomical tables.[2039]

With the end of the 10th century, Sayili observes, there came about a new stage in the history of observatories, with further advances: in administration, a legal status for the institution, involvement of more specialised staff, and better and larger instruments.[2040] Rulers also played a more substantial role, the observatory in its ideal form becoming a royal institution.[2041] Thus, in relation to instruments, Abu'l-Wafa (940-998) who worked at the observatory of the ruler Sharaf al-Daula, made observations using a 20 ft quadrant and a 56 ft stone sextant, and a wall quadrant, which he built himself for observing the stars.[2042] At Shiraz, in the year 969, Al-Sufi was asked by Adud al-Dawla to measure the obliquity of the ecliptic, an operation done with the help of a ring several meters in diameter.[2043] In the meantime, at Khwarizm, Al Biruni was engaged in observations of lunar eclipses using equally large instruments.[2044]

[2035] I,e. O. Neugebauer: *A History of Ancient Mathematical Astronomy* (Verlag, 1975), 3 vols; p.9.
[2036] W. Hartner review of O. Neugebauer: A History of Ancient Mathematical Astronomy, Verlag, 1975; 3 vols; in *Journal for the History of Astronomy*; 9; pp 201-212; at p. 202.
[2037] Al-Biruni: *Tahdid Nihayat al-Amaqin;* op cit; p. 79.
[2038] J.E. Montucla: *Histoire des Mathematiques;* 4 vols; Paris; 1799-1802; vol 1; p. 357.
[2039] Ibn Yunus: Kitab al-Zij; op cit; pp. 126-7; E.S. Kennedy: a Survey; op cit; pp. 125; 134-5; A. Sayili: *The Observatory;* op cit; p. 103.
[2040] A. Sayili: *The Observatory*; op cit, p. 121.
[2041] Ibid.
[2042] G. Sarton: *Introduction*; op cit; vol 1; p. 666.
[2043] F. Micheau: The Scientific; op cit; p. 993.
[2044] A.I. Sabra: The Scientific Enterprise; op cit; pp. 186-187.

A century or so after, an observatory was built by the Seljuk Sultan Malik Shah (ruled 1072-1092), in Ispahan.[2045] There, he gathered together a large group of the most distinguished astronomers, amongst whom were al-Khayyami, Abu'l Muzaffer and Al-Wasiti.[2046] An enormous amount of money was spent for the purpose, and the observation lasted for over thirty years.[2047] The instruments used were much bulkier than before, the aim being to minimise error as much as possible.[2048] Each piece was also dedicated to a particular class of observations.[2049] Haji Khalifa, on the authority of Abd al-Wajid speaks of the *Zij Malikshah* by Umar Khayyam.[2050] Qutb al-Din al-Shirazi, too, mentions Umar Khayyam's zij.[2051]

In this high medieval period, there also seems to be observation made in the Muslim west. Johnson speaks of observatories at Cordova, Seville, and Toledo, and also in Morocco, and describes them as intensely active.[2052] There is reference to an observatory in Seville, or more precisely to the tower used by Jabir Ibn Aflah. This lofty tower was the minaret of the Friday mosque of Seville, later to be transformed into the famed Giralda Tower. Aschbach and Mamuni speak of this place as the first observatory built in Europe.[2053]
In North Africa, the Star Tower was located in the city of Fes, and was used for observations of the new moon. This tower is said to have been in existence in the 12th century and to have remained in existence for centuries after.[2054] Special openings were provided on its top, serving as guides indicating the directions of observation for various months.[2055] Al-Mamuni cites an unpublished source which contains information

[2045] G. Sarton: *Introduction;* op cit; vol 1; p. 760.
[2046] A. Sayili: *The Observatory*; op cit; p. 161.
[2047] M. Al-Wabkanwi: *Al-Zij al-Muhaqqaqi*... Ms. Istanbul; Ayasofya Museum Library; No 2694; p. 23b.
[2048] G.M Wickens: The Middle East, op cit; p. 117.
[2049] Baron Carra de Vaux: Astronomy; op cit; p. 396.
[2050] Haji Khalifa: *Kashf al-Zunun*; ed. Flugel; 7 vols (1835-58), vol 3; p. 570.
[2051] Qutb al-Din: *Nihaya al-Idrak*; mss Istanbul; Topkapi Museum Library; Ahmet III; mss 3333; p. 140a; 3334; p. 268a.
[2052] M.C. Johnson: Greek, Moslem and Chinese instrument design in the surviving Mongol Equatorials of 1279; *ISIS*; vol 32; p. 36.
[2053] J. Aschbach: *Geschichte Spaniens und Portugals zur Zeit der Herrschaft der Almoraviden und Almohaden*; 2 vols (Frankfurt; 1837); vol 2; pp. 274; 279; Arabic translation by Muhammad Abdullah Inan: *Tarikh al-Andalus fi Ahd al-Murabitin wa'l Muwahhidin;* 2 vols (Cairo; 1941), Vol 2; pp. 255; 260;
M. Al-Mamuni: *Al-Ulum wa'l Funun ala Ahd al-Muwahhidin* (Tatwan; 1950), p. 109.
[2054] A. Sayili: *The Observatory*; op cit; p. 184.
[2055] Ibid.

concerning this tower.[2056] Al-Mamuni also mentions a later source indicating that the tower remained standing for a considerable length of time.[2057]

In the 13th century the largest and most advanced observatory to date was built at Maragha in Azerbaijan; the only contribution by the Mongols to learning, although that was far from being their aim, Hulagu, the observatory's sponsor, being only interested in the star signs to carry out his wars on Islam. He employed Nasir Eddin at Tusi as astrologer, Nasir Eddin having advised Hulagu to carry the onslaught on Baghdad in 1258.[2058] The observatory was situated on a hill near to the town of Maragha, the imposing building occupying an esplanade of some 150 by 350 metres, and included a dome with a hole in the top to allow the sun's rays to pass. Maragha had a library of 40,000 volumes,[2059] and its instruments, including quadrants, armillaries, astrolabes, were all designed and constructed at the site.[2060] The instruments made of rings had special purposes: ecliptical, solstitial and equatorial armillaries; a meridian armillary consisted of a graduated bronze ring in the shape of an alidade set upon the meridian to measure solar altitudes in zenith distance; a large stone sundial accurately aligned to the meridian and used only for determining the obliquity of the ecliptic; an equatorial armillary made in the form of a bronze ring set firmly parallel to the plane of the equator; and a parallactic instrument, a type of transit used to measure the zenith distance of a star or the moon at culmination.[2061] Twelve years of observations and calculations at Maragha resulted in the Ilkhanide tables in 1271. Before then, on the 8th of September 1264, the astronomers at Maragha observed the maximum height of the sun on the meridian and found it to be 55^0 29';[2062] on 26th October, it was 37^0 35'; on 5th March 1265, it was 49^0 36' 30".[2063] The Maragha observatory survived for a few decades till the beginning of the 14th century.[2064]

[2056] M. Al-Mamuni: *Al-Ulum wa'l Funun;* op cit; p. 113.
[2057] Ibid.
[2058] Baron G. d'Ohsson: *Histoire des Mongols;* op cit; Vol 3; pp. 225-6.
J. Glubb: *A Short History;* op cit; p. 207.
[2059] F. Micheau: The Scientific; op cit; P.1003.
[2060] A. I. Sabra: The Scientific; op cit; pp. 186-187.
[2061] B.C. de Vaux: Astronomy; op cit; p.396; and S.A. Bedini: Scientific instruments; in *Dictionary of the Middle Ages*; op cit; vol 11; pp. 95-103.
[2062] G. Saliba: Solar observations at the Maragha observatory before 1275: a new set of parameters; in *Journal of History of Astronomy*; vol 16 (1985); pp. 113-122. at p.118.
[2063] B. Hetherington: *A Chronicle*; op cit; p. 158.
[2064] F. Micheau: The Scientific; op cit; P.1002.

The Samarkand observatory, dating from 1424, was the accomplishment of Uluh Beg (1394-1449); a prince keen on the sciences, who also enjoyed the company of, and discussions with scholars.[2065] The observatory of Samarkand was a 'monumental' building equipped with a huge meridian, made of masonry, a symbol of the observatory meant as a long lasting institution.[2066] It was equipped with a 'Fakhri sextant', of a radius of 40.4 metres. John Greaves writing in 1652 says that, according to a trustworthy Turkish astronomer, the radius of that meridian arc was about equal to the height of the dome of the Ayasofya Mosque in Istanbul,[2067] thus, approximately fifty metres. Al-Birjandi states that the astronomers measured the obliquity of the ecliptic with the help of the suds-i-Fakhri.[2068] The instruments mentioned by al-Khashi are a parrallactic ruler, armillary sphere, equinoctial armilla, the two ring Suds-i-Fakhri, azimuthal quadrant, the sine and versed sine instruments, the small armillary sphere (with four rings).[2069] Al-Kashi (1380-1429), a very able astronomer and also the author of the finest eastern treatise on arithmetic, headed the staff,[2070] which involved more than 100 scientists.[2071]
Samarkand, in the early decades of the 15th century, Krisciunas insists, was 'the astronomical capital of the world.'[2072] Observations were made there for almost three decades, and resulted in 1437 in the Ilkhanide Tables, of which a hundred copies still exist.[2073] These included some excellent sine and tangent tables as well as improved planetary parameters and star positions. An unusually large number of these were based on original observations rather than on mere updating of Ptolemy or al-Sufi.[2074] Calculations helped devise a catalogue of 1012 stars, and measure the solar year to 365 days, 6 hours, 10 minutes and 8 seconds.[2075] The star catalogue later aroused much interest in Europe, especially in the early

[2065] Ibid; pp. 1003-4.
[2066] A. Sayili: *The Observatory*, op cit, p. 271.
[2067] J. Greaves: *Binae Tabule Geographicae* (London; 1652), pp. 9-10.
[2068] Al-Birjandi: *Sharh-i-zij Uluh Biyk;* ms Istanbul; Nuruosmaniye Library; No 2939; p. 56a.
[2069] Al-Kashi: *Risala;* ed W.W. Barthold; Memoires de l'Academie des Sciences de Russie; VIII em serie; Vol 13; No 5 (Petrograd; 1918), pp. 1-3.
[2070] J. North: *The Fontana History of Astronomy and Cosmology* (Fontana Press, London; 1994), p. 200.
[2071] J.S. Bailly: *Histoire de l'Astronomie Moderne depuis la Fondation de l'Ecole d' Alexandrie* in A. Sayili: *The Observatory;* op cit; p. 259.
[2072] K. Krisciunas: The Legacy of Uluh Beg; at http://www.ukans.edu/~ibetext/texts/paksoy-2/cam6.html
[2073] F. Micheau: The Scientific; op cit; p. 1004.
[2074] J. North: *The Fontana History of Astronomy; op cit;* p. 200.
[2075] D. Abbot ed: *The Biographical Dictionary of Scientists, Astronomers*; F. Muller; London; in B. Hetherington: *A Chronicle*; op cit; p. 191.

days of serious Islamic studies in the early 17th century.[2076] The observatory at Samarkand remained active until nearly 1500,[2077] before being brought down following political upheavals in the region. Its remains from 1908 yielded a fragment of the gnomon used to determine the height of the sun from the length of the shadow. There were also remains of a building of cylindrical shape with a complex interior plan.[2078] Among the remains was a portrayal of the ten celestial spheres with degrees, minutes, seconds and tenths of seconds, the seven moving planets, fixed stars and the terrestrial sphere etc.[2079]

Krisciunas insists that in the Samarkand observatory the role of permanently mounted astronomical instruments was understood. So was the systematic basis of observation, for lengthy periods of time, 17 years or more of the same phenomena being pursued.[2080] Ten or fifteen years were required due to conditions suited to the determination of matters pertaining to the planets, making it necessary to observe them only when such conditions were present, Krisciunas explains.[2081] In his letter to his father, the astronomer al-Kashi writes:

> 'As to the inquiry of those who ask why observations are not completed in one year but require ten to fifteen years, the situation is that there are certain circumstances suited for the determination of matters pertaining to the planets, and that they should be observed when these conditions obtain. One needs, e.g., to have two eclipses in both of which the eclipsed parts are equal and on the same side, and both these eclipses have to be near the same node. Likewise, two other eclipses conforming to other specifications are needed, and still other cases of a similar nature are required. It is necessary to observe Mercury at a time when it is at its maximum morning elongation and once at its maximum evening elongation, in addition to certain other conditions, and a similar situation exists for the other planets.
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> 'Now, all these circumstances are not met within a single year, so that their observations cannot be completed in one year. It is necessary to wait until the required circumstances obtain, and then if there is cloud at the awaited time, the opportunity is lost and

[2076] J. North: *The Fontana History of Astronomy; o*p cit; p. 200.
[2077] L. Sedillot, 1853, in R. Morelon: General Survey of Arabic Astronomy, in *Encyclopaedia* (Rashed ed), op cit, vol 1, pp 1-19; at p. 14.
[2078] F. Micheau: The Scientific; op cit; at pp. 1003-4.
[2079] Ibid.
[2080] K. Kruiscinas: The Legacy; op cit.
[2081] Ibid.

> gone, and it is necessary to wait for another year or two for the repetition of the needed circumstances. Ten or fifteen years are required for this reason.'[2082]

It also takes Saturn 29 years to return to the same position amongst the stars (that being its period of revolution about the Sun), and a period of 29 years might have been the projected length of the Samarkand program of observations.[2083]

Islamic observatories were the forerunners of modern observatories, whether with regard to their organisation, the instruments and methods used, the objectives assigned for each astronomer or observation, state involvement, etc. One major innovation was the tendency to narrow branches of specialisation, and to involve large groups of scholars in common endeavours. There were thus, calculators, arithmeticians, geometers, astronomers, astrologers, observers and instrument designers who were specialised in their own branch of knowledge only.[2084] The use and manipulation of astronomical instruments necessitated working in groups of observers, so that, in this case at least, the collaboration of astronomers of the same specialisation was also required.[2085] That the foundation and functioning of the Islamic observatory was dependent upon the cooperation of many scientists is clearly stated by Islamic writers.[2086] The emphasis upon astronomical work and observation in groups seems to explain the sudden appearance of impressive staffs in Islam in the observatories.[2087] Hartner insists that it was only in the 17th century, thanks to Brahe, that high standards of Islamic observation were reached again by the Europeans.[2088]

[2082] Al-Kashi: *Letter to his Father;* Ms.; Sipahsallar Mosque Library; Tehran; No 2916.pp. 515b-516a.
[2083] K. Kruiscinas: The Legacy; op cit.
[2084] A. Sayili: *The Observatory;* op cit; pp. 249-52.
[2085] Ibid; p. 30.
[2086] Nizami-I-Nishapuri: *Kashf al-Haqaiq; Ms Istanbul*; Ayasofya; No 2696; Bursa; pp. 6a-6b.
[2087] A. Sayili: *The Observatory;* op cit; p. 30.
[2088] Essay review by W. Hartner of O. Neugebauer; op cit; p. 211, note 20.

5. Transfer of Muslim Astronomy to the Christian West:

The home of Muslim astronomy in Europe, of course, was Spain. It was from Spain, that the early treatises on the astrolabe travelled North of the Pyrenees in the late 10th century following exchanges between Lorraine and Muslim Spain. John, Abbot, of Gorze (in Lorraine) travelled to Spain as a result of exchanges between Abd Errahman III, caliph of Cordoba, and the German emperor Otto the Great during the years 970-74. After three years spent in Muslim Spain, John in all probability brought back with him manuscripts of an Islamic scientific nature.[2089] John was helped in his enterprise by Spanish Jews who understood Latin.[2090] Soon after his return, Lorraine exhibited astronomical knowledge and usage of the astrolabe on the Islamic model.[2091] Following John was Gerbert of Aurillac (930-1003) (later Pope Silvester II), who also spent some time in Ripoll Catalonia, and subsequently introduced the astrolabe and the armillary sphere North of the Pyrenees.[2092] Subsequently, Spain, in the words of Haskins, remained the home of astronomical tables and astronomical observation from the days of Maslama (al-Majriti) (d.1007) and al-Zarqali (1029-1087) to the days of Alfonso the Wise (1252-1284); the meridian of Toledo was the standard of computation for the West.[2093] In between, in the 12th century, it was also to Toledo that scholars flocked from all Christian lands to translate Muslim science from Arabic into Latin, local Spanish dialects and also Hebrew, and later on into French, German and English. Amongst such translators were the Italian Gerard of Cremona, who among others translated the Toledan tables of al-Zarqali and Jabir ibn Aflah's *Islah al Majisti* (Correction of the Almagest) a refutation of Ptolemy,[2094] and John of Seville, who made translations that included the astronomical treatises of al-Battani and Thabit Ibn Qurra, *al-*

[2089] J. W. Thompson: Introduction of Arabic science into Lorraine in the tenth Century," *ISIS* 12 (1929): 187-91; M. C. Welborn: 'Lotharingia as a center of Arabic and scientific influence in the eleventh century,' *ISIS* 16 (1931) pp.188-99.
[2090] J.W. Thompson: The Introduction of Arabic Science; op cit; pp 189-90.
[2091] M.C. Welborn: Lotharingia; J.W. Thompson: The Introduction of Arabic Science.
[2092] R. Allen: Gerbert Pope Sylvester II; *The English Historical Review* (1892), pp 625-68; D.R. Hill: *Islamic Science,* op cit, p. 221.
[2093] C.H. Haskins: *Studies in the History of Mediaeval Science,* (Frederick Ungar Publishing Co. New York. 1967 ed), p. 18.
[2094] R. Lemay: Gerard of Cremona; *Dictionary of Scientific Biography;* op cit; Vol 15; Supplement I; pp. 173-92.

Madkhal ila sinaat ahkam al-nujum (Introduction to the Predictions of the Stars) of al-Qabisi, and the treatise on the astrolabe by Al-Majriti.[2095]

The introduction of Islamic astronomy into England was the work of Walcher of Malvern (also from Lorraine), who had come into possession of an astrolabe. It was he, who for the first time in Christian Europe, on 18 October 1092, used the astrolabe for serious observational purposes to determine the time of a lunar eclipse that he had observed in Italy; and this had momentous consequences on European astronomy.[2096] Walcher relied heavily on Petrus Alphonsi, a Jewish convert to Christianity, who served in both Spanish and English royal courts, and who is also credited with the introduction of Muslim astronomy into England.[2097] Petrus also assisted early English scholars including Adelard of Bath. One of his astronomical treatises, based on Muslim astronomy is preserved at Oxford University.[2098] It includes a concordance of eras for the year 1115, a series of tables for the various planets, and an explanation of the use of the chronological tables. Adelard of Bath himself made a translation of Maslama's edition of Al-Khwarizmi's astronomical tables in 1126.[2099] The cathedral of Chartres in France is thought to have contained a manuscript of Adelard's version of Al-Khwarizmi's tables.[2100] Adelard also translated a treatise by Abu Ma'ashar: the *Isagoge minor* (Shorter Introduction to Astronomy). Following Adelard, another Englishman, Robert of Chester, made an adapted version of al-Battani's and al-Zarqali's tables in 1149, whilst Roger of Hereford (fl. 1176) wrote astronomical tables for the meridian of Hereford based on the tables of Toledo and Marseilles.[2101]

In France, Muslim learning was mainly located in the southern regions that were then part of Spain. The southern French Jews, such as Abraham Ibn Ezra and the Tibbonide family, who mastered Arabic, local dialects as well as Latin, played a leading part in this spread of Islamic learning. By the 13th century, Montpelier was a well-known centre of Muslim astronomy (and also medicine). Marseilles, too, played its part, when in 1140, Raymond (of Marseilles) wrote *Liber Cursuum Planetarum*, an astronomical treatise with tables based on the *Toledan Tables*. He

[2095] C.H. Haskins: *Studies*; op cit; p. 13.
[2096] O. Pedersen: *Astronomy*, op cit, p. 312.
[2097] See J.H.L. Reuter: *Petrus Alfonsi: an examination of his works; their scientific content, and their background.*' Unpublished Ph.d thesis (Oxford; 1975), p. iii.
[2098] C.H Haskins: *Studies,* op cit, p. 117.
[2099] L. Cochrane: *Adelard of Bath* (British Museum Press, 1994).
[2100] C.H. Haskins: *Studies,* op cit, p. 90.
[2101] G. Sarton: *Introduction*; Vol 2; op cit; p. 404.

declared himself the first Latin 'to acquire the science of the Arabs,'[2102] obviously little aware of his predecessors: Gerbet, Walcher etc. Amongst Raymond's inspirations were al-Battani, Mash-Allah, and above all Al-Zarqali from whom Raymond's works are largely drawn.[2103]

Although Islamic civilisation declined in the 13th century, its impact outlived it. When Alfonso of Castile (1223-84) sought to construct an armillary sphere, 'the finest and best that had yet been made', he turned to the Muslims.[2104] He had Al-Zarqali's *safiha* was translated into Latin. Subsequently, Regiomontanus published a collection of problems on the 'noble instrument of the *safiha*.'[2105] Regiomontanus also studied Al-Farghani's *Compendium* of astronomy, which was translated into Latin by both Gerard of Cremona and Johanes Hispalensis.[2106] Melanchthon published an edition based on the work of Regiomontanus at Nuremberg in 1537.[2107]

The greatest Islamic impact on Renaissance scholars was on Copernicus. He relied heavily in his book *De Revolutionibus* not just on al-Zarqali and al-Battani but most of all on Ibn al-Shatir and the astronomers at the Maragha observatory for his planetary models and theory.[2108] In the 1950s, Kennedy discovered that the geocentric planetary models of Ibn al-Shatir in *Nihayat al-sul* were mathematically identical with the heliocentric models of Copernicus.[2109] Saliba made a very convincing demonstration of this borrowing by Copernicus.[2110] North, equally, stresses that Copernicus made repeated uses of his Muslim predecessors, and traces the line of transmission to Italy at about the time Copernicus studied there.[2111]

Just like Copernicus, the mathematician Laplace relied heavily on Ibn Yunus's tables from his *Al-Zij al-Hakim,* using the tables in his determination of the 'Obliquity of the Ecliptic' and the 'Inequalities of Jupiter's and Saturn's; whilst the American Newcomb used its

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[2102] C.H. Haskins: *Studies,* op cit, p. 98.
[2103] P.K. Hitti: *History*, op cit, p. 571.
[2104] Carra de Vaux: Astronomy; op cit p. 396.
[2105] Ibid, p. 394-5.
[2106] Ibid, p. 381.
[2107] Ibid, p. 381.
[2108] John North: *Astronomy and Cosmology* (Fontana Press, London, 1994), at p. 195.
[2109] See: *The Life and Work of Ibn al-Shatir, an Arab astronomer of the 14th century;* Edited by E.S. Kennedy and I. Ghanem; Institute for the History of Arabic Science (Aleppo; Syria; 1976).
See also D.A. King: Astronomy, in Religion, Learning, (M.J. L. Young et al ed) op cit; p.284.
[2110] at: http://www.columbia.edu/~gas1/project/visions/case1/sci.1.html
[2111] J. North: *Astronomy and Cosmology*; op cit; p. 195.

observations of eclipses in his investigations on the motions of the moon.[2112]

Islamic astronomical knowledge also travelled East; in the year 1266, Jamal Eddin reached Peking taking with him an equatorial armillary sphere, a plane sundial for unequal hours, an equinoctial dial, a celestial globe and an astrolabe.[2113]

Concluding Words on Astronomy

The preceding outline has amply proved that historians who insist that Islamic astronomy is a mere reproduction of Greek astronomy are wholly mistaken, and are distorting the reality of the subject. Even worse distorters are those many historians who jump from Antiquity (5th century) to the 15th century, thus setting aside all accomplishments of medieval Islamic astronomy, of which those mentioned above are only a fraction.

A fraction, indeed, for note must be made here that in order to form an idea of the true impact of Islamic astronomy, as with other sciences, it is imperative to return to some very old secondary material, principally dating from the late 19th and early 20th centuries.[2114] These sources include material that cannot be found in mainstream works on the history of astronomy such as those by Duhem,[2115] Delambre,[2116] Pedersen,[2117] etc. It is also imperative that the matter is studied not by just expert Arabists, or just by astronomers, as unfortunately has been the case for much of Islamic science, but by people expert at Arabic/Islamic culture, history and astronomy. The manuscript sources of Islamic astronomy must be revisited to re-assess the

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[2112] S. M. Ziauddin Alavi: *Arab Geography in the Ninth and Tenth Centuries*, Published by the Department of Geography Aligarh (Muslim University, Aligarh 1965), p. 36.
[2113] B. Hetherington: *A Chronicle*; op cit; p. 159.
[2114] I.e: M. Steinschneider: Etudes sur Zarkali; *Bulletino Boncompagni*; vol 20.
M. Steinschneider: *Die europaischen Ubersetzungen aus dem Arabischen bis Mitte des 17.* Jahrhundert (1904-5), repr.
-J. Bensaude: *L'Astronomie Nautique au Portugal* (Meridian Publishing, Amsterdam, 1967).
-H. Suter: *Die mathematike; op cit.*
[2115] P. Duhem: Medieval Physics, in R. Palter edition: *Toward Modern Science*; op cit; pp 47-52.
[2116] J. Delambre: *Histoire de l'Astronomie Ancienne;* op cit.
[2117] O. Pedersen: *Early Physics and Astronomy* (Cambridge University Press, 1974).

contents of some of the works already studied, as there is plenty in them that has, for one reason or another, not been given its true worth. Most of all, it is the manuscripts that have not been touched at all that ought to receive focus. Some such works have been lying dormant for centuries, and include information that might help understand the Islamic side of the science. King holds that some of this literature survives in about 10,000 manuscript volumes preserved in the libraries of south western Asia, North Africa, Europe, and the USA.[2118] During the past 200 years, according to King, only a very small number of scholars have turned their attention to a fraction of this surviving material. Catalogues of varying quality exist for some library collections, but there are many important collections of scientific manuscripts which are not yet catalogued at all.[2119] This mammoth task can begin with an exploration of the bibliographies prepared by Suter, already cited, Sezgin,[2120] and the very informative recent work by Rosenfeld and Ihsanoglu,[2121] and then progress from there.

[2118] D.A. King: Astronomy; op cit; at p.274.
[2119] Ibid.
[2120] F. Sezgin: *Geschichte des arabischen Schrifttums* (vol 6 for astronomy) (1978).
[2121] B. Rosenfeld and E. Ihsanoglu: *Mathematicians;* op cit

CHEMISTRY

Any outlines on Islamic chemistry, which can be found in modern history books are usually dire. They omit nearly all Islamic accomplishments in chemistry and, as with other sciences, suppress all the excellent old references and works on the subject accomplished by late 19th-early 20th century historians. The little they grant Muslim chemistry generally focuses on the folkloric side of the subject, such as 'the stone of wisdom,' 'the elixir of life,' etc. They also attribute all Islamic achievements to their Greek predecessors. This chapter seeks to refute these and other misconceptions, and show the achievements of Muslim chemists.

1. Misrepresentations of Islamic Chemistry:

The misrepresentations of Islamic chemistry come in a variety of forms and substance. Here five dominant cases of misrepresentations are noted. The first relates to the usual claim, that Muslim science accomplished nothing, and at best is nothing but a mere reproduction of Greek science. The second deals with misattribution of authorship; the third is common to most historians dealing with Islamic science, namely their reliance upon authorities which themselves lack authority in their subject; the fourth deals with another major weakness found in nearly all Western writing on Islamic science and civilisation, and which leaves every reader baffled: the same author praising Islamic achievements and demeaning them in the same breath; the fifth, again, brings into focus the generally condescending attitude towards Islamic sciences, in this instance, chemistry being identified with alchemy.

The first of these issues, which requires little comment here, as it is repeatedly dealt with in respect to every science, relates to the usual

assertion that Muslim science is nothing but Greek, here referring to chemistry, Stillman, for instance, tells us that:

> 'It is Arabian alchemy that preserved the traditions and literature of the Alexandrian-Greek alchemists, derived from the Syrians during the long period when the culture of Christian Europe was inhospitable to its development. From such Syrian and Arabian manuscripts as have been preserved and examined, it does not appear that during the centuries of their alchemical activity any very notable additions were made to the practical chemistry known to the ancients of the times of Pliny, Dioscorides or the writers of the Theban papyri. Nor was the development of theories of matter and its changes in the direction of a distinct advance over the Neoplatonism of their Alexandrian masters.

The Arabian writers seemed to have no thought of challenging the authority of the traditional masters of the Art.'[2122]

Stillman then concludes with Von Lippmann:

> 'Arabian alchemists were numerous from the 9th to the 14th century, Von Lippmann enumerating about sixty Arabian authors who wrote or were reputed to have written on alchemy during that period. Of the contents of many of these writings very little is known. From such writings as have been accessible, Von Lippmann expressed the judgement that neither the Syrians nor the Arabians enriched the knowledge of chemistry with a single new and original thought, being dependent on the authority of the Greek alchemists and producing only increased confusion by their efforts to explain what was to themselves incomprehensible.'[2123]

As it progresses, this chapter will show how inane these comments are.

The second issue relates to the personality of Jabir (Jabeer) (Ibn Hayyan) (722-815); a point of controversy summed up by Dunlop.[2124] Primarily, the question is whether Jabir and the Latin Geber are one and the same, and whether the unrealistic figure of 3000 or so works attributed to him are all his. Many factors enter this equation. First Jabir, by being one of the earliest Muslim scientists (8thcentury) causes his case to be complex. Secondly, he shares his name with another Jabir (Ibn Aflah) the astronomer, who lived in Spain, and that confused many of those who

[2122] J.M. Stillman: *The Story of Alchemy and Early Chemistry* (Dover Publications; New York; 1960), pp. 174-5.
[2123] Von Lipmann; pp. 396 ff and p. 424 in J.M. Stillman: *The Story of Alchemy;* p. 182.
[2124] D.M. Dunlop: *Arab Civilisation 800-1500 A.D* (Longman Group Ltd, 1971), pp 209-11.

dealt with Islamic science. And the early translators or editors of Islamic science have created much confusion, attributing what belongs to Ibn Aflah to Ibn Hayyan and vice versa, besides confusing locations, centuries and so on. The two Gebers, Lorch notes,[2125] have seldom been distinguished until recently. Hence Nicolas Antonio[2126] attributes the *Summa perfectionis* etc, to 'Geber, alias Mahomed Geber filius Aflah'' immediately after discussing the genuine *Expositio in Ptolemaei Novem Libros*.[2127] It was to Jabir Ibn Hayyan or a composite Geber that Doctor Johnson[2128] referred in his definition of 'Gibberish' as.... Anciently written gebrish,.... Probably from the chymical cant, and originally implied the jargon of Geber and his tribe.'[2129]

Most of those who followed fell victim to this confusion, including modern historians such as Sherwood Taylor, who says:

> 'Geber was long thought to be the eighth century Arabic alchemist Jabir, but it would seem that the Latin works which go under the name of Geber are not earlier than 1200 and it is at least doubtful if they have Arabic originals.'[2130]

Stillman confuses things further:

> 'Djaber was a writer of the eighth or ninth century, looked up to with reverence for his learning by the Arabian writers. His contribution to alchemy an chemistry are, however, not important. The false Gheber was a writer of the 13th or 14th centuries, whose personality is unknown, who possessed much more advanced knowledge of chemistry and who, for his greater security or in order to obtain greater prestige for his writings, chose to have them accepted as translations of Arabian works of Gheber (Djaber). As a matter of fact, they were probably written in Latin, following no Arabian original. This judgment long suspected by historians, has been finally confirmed by Berthelot.'[2131]

The outline on Jabir further on will show how mistaken Sherwood Taylor, Stillman and others with similar views are.

[2125] R.P. Lorch: The Astronomy of Jabir Ibn Aflah; op cit; p. 86.
[2126] *Bibliotheca Hispana Vetus* (1788); II; p. 404.
[2127] In R.P. Lorch: The Astronomy of Jabir Ibn Aflah; op cit; p. 86.
[2128] *A Dictionary of the English Language*; (1755).
[2129] In R.P. Lorch: The Astronomy of Jabir Ibn Aflah; op cit; p. 86.
[2130] F. Sherwood Taylor: *A Short History of Science* (William Heinemann Ltd, London, 1939), p.113.
[2131] J.M. Stillman: *The Story of Alchemy;* op cit; p. 176.

The third and more serious problem, which deserves scrutiny here, is that Western historians of science in general, and historians of particular sciences, write on such histories, having little, or no knowledge of the particular histories of China, India, and the Muslim world, nor any understanding of the languages of these civilisations. As is well known, all these civilisations played a major, if not the major part in the evolution of all sciences, especially during the crucial 'Dark Ages' of Western Christendom. Yet, because the history of science, or the history of specific sciences, is dealt with by historians who have little or no knowledge of these civilisations, it means that between 70 and 90% of the original foundation of the history of such sciences is ignored or mishandled. To make matters worse, such historians of science, instead of limiting the titles of their works to Europe when writing on the history of science, or of a science, they seek to be global, calling their work, for instance 'a history of physics,' when only the European experience is included. This is repeated in every single science, ending up creating a history that is Eurocentric in substance, but purportedly widened to the whole world. Thus, in this particular instance, the history of European chemistry is presented as the history of chemistry. This fallacy, repeated in every science has resulted in a horrendously distorted view of the history of every single science. If one takes Chinese science in this instance, had it not been for Needham,[2132] who gave the Chinese civilisation its due place, the Chinese role, absolutely decisive in the birth of most of what we have today, would, otherwise, have never been understood. Islam has not had its Needham, yet, although Sarton, Sezgin,[2133] and others referred to here, have given little glimpses of its role in the history of science.

Much worse, even, is when Western historians with little grasp of those non Western civilisations, or their languages, still include a few paragraphs on such civilisations, and pass judgment on such civilisation, generally derogatory, and then come out with conclusions and theories, which completely distort the history of science. Hence, in the case of Islamic science, to fill the Islamic space, such historians rely on their inadequate knowledge, or generally rely on some previous authorities, themselves lacking in authority. Thus, many Western historians rely on the likes of Lynn White Jr and Clagett in mechanics and technology; Delambre and Duhem in relation to astronomy; Rashdall on the history of universities, etc, and so repeat and perpetuate these authors' aberrations,

[2132] J. Needham: *Science and Civilisation in China;* 7 vols (Cambridge University Press; 1954 ff.)

[2133] F. Sezgin has been the nearest to Needham. His work in German, though, has remained mostly inaccessible to the general audience.

fallacies and prejudices endlessly. In the specific case of chemistry, many modern historians rely on both Kopp and Berthelot, yet, both Kopp and Berthelot, as Holmyard (both an Arabist and chemist, thus very well placed to pass on judgment) notes, give either little space, or erroneous and misleading information on Islamic chemistry, due partly to Kopp's unfavourable opinion of Islamic chemistry, and the hasty conclusions drawn by Berthelot from his superficial studies of Islamic material.[2134] And neither Kopp, nor Berthelot were Arabists, which, as Holmyard notes, makes their conclusions on Muslim chemistry: 'unable to stand the test of criticism as more information is available.'[2135] Holmyard provides further light on this issue in an essay that remains probably unique in this respect.[2136] Holmyard shows how Berthelot, a qualified chemist, had no understanding whatsoever of Arabic, and yet dealt with Muslim chemistry, relying on the help of an Arabist, Houdas, who understood nothing in chemistry, and was thus completely unable to convey the correct technical terminology. Holmyard gives instances of how Houdas misled Berthelot with regard to critical technical expressions and concepts, and how Berthelot himself legitimised such mistranslations by asserting that he had made a strict revision of such translations, when he himself understood not a word of Arabic.[2137] In one instance, in a separate article, Holmyard shows how Berthelot alters completely even the meaning of Jabir's works.[2138] One of such titles is: *Kitab Istuqus al-Uss al-Awwal.*[2139] Berthelot translates the title as *Le Livre d'Estages, le Premier Myrte (myrtle)*,' thus confessing ignorance of the meaning of *istuqus* and misreading *as* (myrtle) for *uss* (base or foundation.).[2140] Hence, the correct title should be: *The Book of Foundation, the First Base.*[2141] Which differs completely from a book on Myrtle, and gives Jabir's work an entirely different complexion. Moreover, Berthelot being knowledgeable in Greek, and medieval Latin studies, ended up in the same quandary, and committing precisely the same errors many, or most of his colleague historians of science, did in their own subjects. Berthelot

[2134] E.J. Holmyard: Chemistry in Islam; in *Toward Modern Science* (R. M. Palter ed); op cit; Vol 1, pp. 160-70. At pp 160-1.

[2135] Ibid.

[2136] E.J. Holmyard: A Critical examination of Berthelot's work upon Arabic chemistry. *ISIS,* vol 6; pp. 479-99; reprinted from *Chemistry and Industry Review*, Published by the Society of Chemical Industry; vol 42. 958-63; 976-80 (London; 1923).

[2137] Ibid; pp. 482-3.

[2138] E.J. Holmyard: Jabir Ibn Hayyan; in *Proceedings of the Royal Society of Medicine*; vol 16 (1923), pp. 46-57.

[2139] Lithographed. India (1891).

[2140] E.J. Holmyard: Jabir Ibn Hayyan; p. 48.

[2141] Ibid.

found himself on one hand not being able to throw light on the legacy of Islam, which was often transported bodily and unintelligently into the Latin world (during the Middle Ages), and on the other had, reading into the Muslim works meanings and conceptions which were, in fact, of spontaneous, and later European birth. In addition, Berthelot was unable to realise that facts and theories he believed to be definitely European are to be found in the writings of Muslim chemists.[2142]

It is hardly surprising, therefore, to find huge gaps between the writings of Berthelot, Kopp and their followers (the majority of historians of the subject,) on one hand, and that of Holmyard, Levey, Ruska,[2143] and Meyerhof (who were more favourable to Islamic chemistry) on the other. Where there is a greater problem, is when historians of science, rather than balancing the two sides, choose, because it suits their anti Islamic prejudices and bias, to use Berthelot or Kopp instead of Holmyard, Ruska and Levey; or when they do worse and suppress from the history of the science any reference to Holmyard, Levey, Ruska etc. The picture that, then, prevails is that of an extremely biased anti Islamic history of chemistry. Here are two instances taken at random. First, Moore's history of chemistry, where the reference to Islamic chemistry is no more than a few paragraphs, and where we read:

> 'In 640 Egypt was overrun by Arabs. They were brave but ignorant. They found books in Egypt on how to make gold and cure ills, which they translated into Arabic, and for a century a stream of books poured into the Mohammedan world through Greece. In this way Egyptian knowledge reached Europe in the form of Latin translations from Arabic works, and some thought that the Arabs were the originators in chemistry… Geber is the principal alchemist… and his books translated into Latin are preserved in European libraries. The latter books date from about the 13th century, and Berthelot, after comparing them with the Arabic writings of Geber, came to the conclusion that they were the work of another hand, and had been attributed to Geber in order to enhance his prestige. It is interesting to note that Berthelot found the Latin works superior from the chemical point of view. This writer is called the pseudo Geber. He was probably

[2142] E.J. Holmyard: A Critical; op cit; pp. 483-4.
[2143] Works such as:
-J. Ruska: *Das Buch der Alaune and salze* (Berlin, 1935).
-J. Ruska: 'Al-Rasi (Rhases) als Chemiker', *Zeitschrift fur Angewandte Chemie* 35, 1912, pp 719-24.
-J. Ruska: 'Die Alchemie des Avicenna,' *ISIS* 21 (1933); pp. 14-51.
-J. Ruska: 'Die Alchemie ar-Razi's', *Der Islam* 22 (1935), 281-319.

> a cleric well versed in science….. Geber made experiments but his writings are full of unintelligible mysticism. His chief aim was to prepare the magical transmuting tincture, elixir, or powder of projection.'[2144]

And, Stillman:

> 'M. Berthelot in his researches has shown clearly the Greek origin of the Arabian alchemy, the connection of their practical chemical knowledge with that of Greek-Egyptian sources, and that much of the later chemical advances previously attributed to the them (the Muslims) were of later origin, and perhaps due to European chemists of the 13th and 14th centuries. Thus, there is no known reference in Arab texts to alcohol, nor to nitric acid, aqua regia or sulphuric acid, inventions attributed to them by Berthelot himself in earlier writing.

Kopp also referring to the Arabian alchemists of the 11th to 13th centuries,[2145] says that from such writings as were accessible at his time one learns no new facts, and though by preserving and transmitting chemical knowledge they contributed to the advance of the science, yet their writings are without interest in the history of the development of Chemistry.'[2146]

These views, shared by the overwhelming majority of Western historians, will be shown in this chapter to be completely wrong. It will be, for instance, clearly shown how Muslim chemistry made numerous breakthroughs Greek chemistry was never acquainted with, and how Muslims did make those inventions denied to them by such historians (such as of acids), as the recipes for such products are found clearly written in Muslim works.

Fourth is the problem found in nearly all works by Western historians dealing with Islamic science and civilisation, that is the countless amount of contradictions found in the same work, and often on the same page, on one hand praising Islamic accomplishments, and on the other deriding them so much that the reader, rather than being enlightened, is left completely confused. Here is an instance from Artz outlining Islamic chemistry, or as he puts it, alchemy.[2147] He says:

[2144] F.J. Moore: *A History of Chemistry* (Mc Graw Hill; New York; 1939), p. 23.
[2145] Kopp: Geschichte der Chemie; I; p. 58. in J.M. Stillman: *The Story;* op cit; pp. 182-3.
[2146] J.M. Stillman: *The Story;* op cit; pp. 182-3.
[2147] F.B. Artz: *The Mind;* op cit; pp. 165-7.

'Modern chemistry grew, in some measure, out of Islamic alchemy. Alchemy seems to have begun in China as early as the fourth century B.C.; the chief goal of Chinese alchemy was the prolongation of life. It is next heard of in Egypt in the first Christian centuries. The Muslim alchemists seem to have derived their inspiration mostly from Egypt. In its beginnings, alchemy was mixed with sheer superstition and magic. The ideas and the recipes of the alchemists were drawn from religion, Greek science and philosophy, from folklore, and from industrial processes such as the making of mercury, ammonia, alum, soda, arsenic, steel, cloth, leather, and glass. It had many connections with astrology and other branches of occultism and with fraudulent deception. The basic beliefs of the alchemists were the idea of Aristotle that all matter consists of the four elements: earth, air, fire, and water, in various combinations, that gold is the "noblest" and "purest" of all metals, silver is next, that the transmutation of one metal into another is possible by an alteration in the admixture of the elements, and, finally, that base metals may be turned into noble ones by means of a precious substance often called the fifth element or quintessence. Along with much experimenting that followed these theories, and the belief that they could discover an "elixir of life" that would prolong life, there was a great deal of practical experimenting done in the making of glass, leather, and cloth, the working of metals, and in the preparation of drugs. The first laboratories in history, about which much is known, were those set up by the Islamic alchemists; they practiced distillation and sublimation and developed much of the chemical apparatus in use up to about I650. The alchemistic treatises usually describe clearly the apparatus employed, but they deliberately treat the substances used in an obscure fashion and it has been nearly impossible to decipher most of the recipes. The commonest excuse given for this mystification is that a plain exposition would result in political upheavals due to the inevitable fall in the price of gold, which would follow a revelation of the secret of transmutation.

The greatest name in Islamic alchemy is that of Geber (Jabir Ibn Hayyan), who may have lived in the ninth century, though many later works of alchemy were also attributed to him. He improved methods for evaporation, filtration, sublimation, distillation, and crystallization. Geber described scientifically the two principal operations of chemistry: calcination and reduction. He knew how to prepare chemical substances like sulphide of mercury,

arsenious oxide and lead carbonate. A large part of his writings were devoted to chemical theories that have since gone with the wind. But the by-products of his work have endured; and his emphasis on the value of experimentation was passed on to later scientists. "The first essential," he wrote, "is that you should conduct experiments. For he who does not conduct experiments will never attain to the least degree of mastery. It must be taken as an absolutely rigorous principle that any proposition which is not supported by proofs is nothing more than an assertion which may be true or may be false."[2148] Rhazes improved on Geber's classification of substances. In place of Geber's traditional classification of mineral substances into bodies (as gold, silver), souls (as sulphur and arsenic), and "spirits" (as mercury and sal-ammoniac), Rhazes classified substances as animal, vegetable, and mineral. A concept much more basic he held, however, was the common theory that sulphur and mercury were the primary principles of things. This lasted as one alternative to the four elements of Aristotle until well into the seventeenth century. Avicenna wrote some chapters on alchemy in one of his longest works. He flatly denies the possibility of transmuting metals, but, in spite of his protests, the alchemistic theories lived on. The work of the Islamic alchemists yielded some positive results, but they never freed themselves from a lot of scientific and metaphysical preconceptions taken over from the Greeks and superstitions inherited from later periods, and, without thermometers, barometers, accurate watches, or air-pumps, their work could never really move into modern conceptions of science. It is as transmitters, rather than as innovators, that they take their place in the long history of science.'[2149]

Out of this outline, one is left greatly confused. First Artz clearly states that modern chemistry grew out of Islamic contributions, that Muslims rid the science of its myths and folklore, that they innovated by introducing experimentation, the modern laboratory, the classification of substances, etc, and then, in the end, he concludes that Muslims were not innovators, but were mere transmitters. It is not just that Artz contradicts himself, but also, as the outline below will show, he contributes many fallacies. The Muslims did transform the science fundamentally from what it was before them. It was they who cleaned it of its folklore and myths, and attacked the works of alchemists seeking to transmute metals. Their writing,

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[2148] E.J. Holmyard: *The Great Chemists* (London, 1929).
[2149] F.B. Artz: *The Mind*; op cit; pp. 165-7.

contrary to what Artz holds, was far from being obscure, and their recipes and experiments were clearly stated. It was also the Muslims who set the foundations of modern chemistry through experimentation, the laboratory, the technical jargon, the manufacturing and use of chemical substances, and so on and so forth. And should anyone fail to be convinced, they only have to compare pre-Islamic alchemy with Muslim chemistry and modern chemistry, and see whether, as Artz and nearly all modern historians on the subject assert, Muslims contributed little or no advances to the subject.

Fifth, as just noted, is that when dealing with Islamic chemistry, Western historians use the word Alchemy instead of chemistry, which also distorts the picture. This corruption is based initially on the misuse of Arabic. The word Alchemy, indeed, is a corrupt translation of the Arabic word Chemia (chemistry,) preceded by the article Al (which means: the), and which the Arabs always use (like the French and others for that matter) in front of their subject such as Al-Tib (medicine) al-Riyadiyat (mathematics) etc... If this was applied to other subjects, it would become al-medicine; al-mathematics, al-geography and so on... Only Lacroix who notes that Alchemy comes from the adjunction of the Arabic article al to chemia,[2150] and Carra de Vaux, who explains the matter, albeit briefly, have had the presence of mind to point to this, however succinctly.[2151] Al-Chemy should be translated literally: The Chemistry and not Alchemy in English, and La Chimie and not l'alchimie in French; just as some old expressions such as Alcoran, Alfaqih (found in pre early 20thcentury literature) have been put into their correct form: The Qur'an; The faqih etc. The fact that only Westerners translated or dealt with the subject of chemistry, followed by very inept Muslim scholars meant that this corrupt word of al-chemy has become the norm.

Other than this linguistic mishap, the main reason why alchemy is used instead of chemistry when dealing with Islamic chemistry is more insidious. Chemistry means a modern science; alchemy means the amateur, the occult, the second or third rate. Alchemy belongs to the Muslims; chemistry, of course, does not. This notion that alchemy ended with the Muslims and chemistry began with Western Christendom has no historical base. The reason is simple: all sciences began in some part of the world, most likely China or the Ancient Middle East, or Egypt, or India, at level: 1, the most basic, and then graduated to levels 2, 3, 4, and

[2150] P. Lacroix: *Science and Literature in the Middle Ages* (Frederick and Ungar Publishing Co; new York; 1964), p.176.
[2151] Carra de Vaux: *Les Penseurs*, op cit; at p. 374.

higher, through the centuries, until they reached us at the level they are, and will evolve in different places in the future. This is the story of every science, and of every sign of our modern world. Thus, it was not that we had alchemy at one point, and then, with Western Christendom it became chemistry. Chemistry began under one form, associated with occult and similar practices, and then evolved, gradually becoming more refined through the centuries until it took the form of the modern science we have today. Holmyard makes a note or how chemistry came to Islam via Alexandria, clothed in mysticism and infected with charlatanry and magic.[2152]

The shift from alchemy to chemistry happened precisely under Islam. It was a study despised and often considered to be unlawful.[2153] Hence, Lacroix points out, in Islam, 'men of superior intelligence' shook themselves free of the purely theosophical views which had too long influenced, to the exclusion of all others, the eastern philosophers and sought in chemistry for something higher than the chimerical transmutation of metals.[2154] Ifrah notes how by stripping it of some of its arithmology and magic, the early Muslim scholars began to prepare the way for the creation and expansion of modern chemistry.[2155] And playing a central role in this shift is the faith of Islam, itself, which bans, shuns, and warns categorically against every form of magic, occult practices etc.[2156]

The other reason why chemistry as a science is due to the Muslims, Durant insists, is that where the Greeks (so far as we know) were confined to industrial experience and vague hypothesis, 'the Saracens' introduced precise observation, controlled experiment, and careful records.[2157] Al-Kindi, for instance, by a series of ingenious experiments was one of the first to discover the secrets of nature, whilst Jabir discovered and analysed red oxide and the dichloride of mercury (a corrosive sublimate), nitric acid, nitrate of silver, etc, and laying down the true principles of chemistry in his research on the fusion, the purifying, and the malleability of metals.[2158]

The Muslims invented and named the alembic *(al-anbiq)*, chemically analysed innumerable substances, composed lapidaries, distinguished alkalis and acids, investigated their affinities, studied and manufactured

[2152] E.J. Homyard: Jabir Ibn Hayyan; op cit; p. 54.
[2153] Ibid.
[2154] P. Lacroix: *Science and Literature; op cit;* p.176.
[2155] G. Ifrah: *The Universal History of Numbers* (The Harvill Press; London; 1994), p. 519.
[2156] See Surah 113, for instance.
[2157] W. Durant: *The Age of Faith*; op cit; p. 244.
[2158] P. Lacroix: *Science and Literature;* op cit; p.177.

hundreds of drugs.[2159] 'A thousand incidental discoveries,' Durant concludes, which turned the pre-Islamic alchemy into chemistry.[2160]

These being roughly some of the generalised forms of distortion of the subject, the following offers an alternative approach to the history of Islamic chemistry that differs from that found in mainstream history, and that also highlights the Islamic role in the rise of modern chemistry and chemical industries.

2. Alternative Approach to the History of Islamic Chemistry:

Firstly, the sources. One of the most reliable sources is Holmyard, who in his *Makers of Chemistry*, for instance, traces the evolution of the science from very early times until the 20th century.[2161] His work includes none of the usual gaps of centuries one finds with others; nor does it include 'sudden', 'enlightened' 'miraculous' breakthroughs out of nothing during the so called Renaissance, which turns science into hocus-pocus. (More on Holmyard as this work progresses.)

Levey's contribution is equally instructive, especially in a good series of articles in *Chymia*,[2162] which deal with a variety of subjects. In Volume 7 (1961) of this review, for instance, Levey deals with inks, glues, and erasure fluids, and makes a preliminary survey of Islamic chemical technology (pp. 57-72). Levey highlights the pioneering works of the Tunisian Ibn Badis (1007-1061), who in *his Umdat al-Kuttab* (Staff of the Scribes) in twelve chapters, writes amongst others on: the excellence of the pen, the preparation of types of inks, the preparation of coloured inks, the colouring of dyes and mixtures, secret writing, the making of paper, and so on. In the same issue Levey also deals with the development of the Islamic atomic theory (pp.40-56). In volume eight, Levey looks at Al-Kindi's views of Aqrabadhins (pharmacists) (pp.11-20), whilst in volume nine, he considers matters of chemical technology and commercial law in Early Islam (pp.19-25). Focus in this latter article is rightly placed on the

[2159] W. Durant: *The Age of Faith;* op cit; p. 244.
[2160] Ibid.
[2161] E.J. Holmyard: *Makers of Chemistry* (Oxford at the Clarendon Press, 1931).
[2162] Edited by H.M. Leicester; University of Pennsylvania Press, Philadelphia.

office of the Muhtasib (Market Inspector), the law and commercial chemical applications.

Other sources are the Islamic manuscripts, themselves. These should be re-read and re-translated if available in translation. Those that have not been looked at should be edited and translated. It is also important to return to older sources, such as Wiedemannn, Singer, Ruska, and Meyerhof.

The second step is a shift of focus; avoiding the usual, stale, dated approach chosen by others, who have elected to demean the contribution of Islamic chemistry, mainly by focusing on the tedious, obscure, and un-scientific aspects of Jabir's work to describe such Muslim chemistry.[2163] Such a partial approach completely distorts the reality of Islamic chemistry as can be seen from the following extracts. Stillman, for instance, tells us:

> 'From the half dozen treatises which are published by Berthelot, one can obtain a fair idea of the kind of writing which characterises the real Djaber: his style is diffuse and verbose. He is interested in the philosophy of matter, its constitution and change rather than in the experimental manipulation……
> From an examination of these works of Djaber, there is not found anything that suggests a real advance over the Greek alchemists, either in knowledge or chemical facts or in theories.' [2164]

And:

> 'The body of the writings of Djaber that have been translated at the instance of M. Berthelot and published by him, are fine spun metaphysical discussions upon the nature of matter and its changes and the application of these. There is very little allusion indeed to anything conveying any comprehensible idea of actual substances or methods.' [2165]

These views by Stillman, shared by most Western historians, are completely false, and Jabir's achievements in scientific terms, as briefly outlined here, are not just considerable, they form the first elements of

[2163] For instance:
-Georges Anawati, Arabic alchemy, *in Encyclopaedia* (Rashed ed*)* pp. 853-85.
-C. Ronan: The Arabian Science; op cit.
And worst of the lot: Seyyed H.S.Nasr: *Science and Civilization in Islam* (Cambridge; 1987).
[2164] J.M. Stillman: *The Story of Alchemy;* op cit; p. 177.
[2165] *Ibid;* p. 179.

modern chemistry in many regards.[2166] This includes his writings on chemical properties in *Al Khawass al-kabir* (The Great Book of Chemical Properties), on weights and measures in *al-Mawazin*, Chemical combinations in *Al-Mizaj*, and dyes in *Al-Asbagh*.[2167] Jabir also built a precise scale that weighed items 6,480 times smaller than the kg; anticipating Dalton by ten centuries; and defined chemical combinations as a union of the elements together, in particles too small for the naked eye to see, without loss of character.[2168] Jabir pioneered in the basic chemical operations of sublimation, liquefaction, purification, oxidation, amalgamation, crystallization, distillation, evaporation, and filtration.[2169] On calcination, for instance, he wrote a whole treatise, of which is this passage:

> 'Souls and spirits [i.e volatile substances like sulphur and sal ammoniac] will not sustain calcinations, since the latter can be affected only with a very hot fire; now spirits will not sustain a very hot fire as they are volatile and fly away from it. Moreover, the aim of calcinations is nothing more than the removal of impurities form bodies and their complete combustion so that the bodies may be purified and remain unadulterated and unsullied; in a spirit, however, there is no necessity for the same treatment as a metallic body, and all that is needed is the first process in calcinations [i.e gentle heating], when the same effect is produced on the spirit as [complete] calcination effects on the metals, namely, full purification. Understand that clearly, therefore. As for the process which is to spirits what calcinations is to metals, I swear by my Master that thou will find it to be sublimation, and on account of that we have devoted a book to sublimation, following the present book.'[2170]

Jabir classified substances into 1. Spirits, i.e substances, which completely evaporate when fired; 2. metals i.e substances, which are fusible and malleable; 3. bodies or mineral substances, i.e fusible or non fusible substances which are not malleable and can be pulverised.[2171] The spirits were sulphur, arsenic, mercury, ammonia and camphor; and the metals

[2166] The best outline on Jabir's works is E.J. Holmyard: Jabir Ibn Hayyan; op cit.
[2167] I. and L. Al-Faruqi: *The Cultural Atlas;* op cit; p. 328.
[2168] Ibid.
[2169] Most particularly from A. M. Kettani: Science and Technology; op cit; at p. 78, and Carra de Vaux: *Les Penseurs de l'Islam,* op cit.
[2170] From *Kitab al-Taklis* (No 61; supra; p. 52); in E.J. Holmyard: Jabir Ibn Hayyan; op cit; p. 57.
[2171] In R. Arnaldez-L.Massignon: Arabic Science; in *Ancient and Medieval Science*; ed by R. Taton (Thames and Hudson; London; English tr; 1963), pp. 385-421. at p. 413.

were lead, tin, gold, silver, copper, iron and *karsini,* a substance which was undiscoverable, according to al-Razi, but which the geographer al-Qazwini identified as used for 'making pots and bells in some countries.'[2172] It might, therefore, have been an alloy like bronze. As for the bodies, they were complex substances containing varying degrees of 'spirit.'[2173] Jabir also offered a theory on the geological formation of metals, and made noteworthy observations on the doubtless existence of the magnetic force.[2174] In his book on furnaces, Jabir gives a description of a furnace proper for smelting metals, and from the fourteenth chapter of the fourth part of the first book *Sum of Perfection*, it is obvious that the method of calcination or oxidising iron, copper, tin, and lead, and also mercury and arsenic were well known to him.[2175] He gives a description of a furnace for distilling, and a pretty detailed account of the glass, stoneware, or metallic aludel and alembic, by means of which the process was conducted.[2176] He was also in the habit of distilling by surrounding his aludel with hot ashes, to prevent it from being broken.[2177] Other contributions by Jabir include recipes for making cheap, illuminating ink for manuscripts, and he mentions the use of manganese dioxide in glass making. He was also acquainted with citric acid and other organic substances.[2178] He identified alkalines, acids, salts, paints and greases, and prepared sulphuric acid, nitro-hydrochloric acid (used to dissolve metals), caustic soda and a multitude of salts such as sulphates, nitrates and potassium and sodium carbonates; his association of metals and salts promoting foundry techniques and glazing processes for tiles and other ceramics.[2179] The method of distilling per descensum, as is practiced in the smelting of zinc, was also known to him, as he describes an apparatus for the purpose, and gives several examples of such distillation in his writings.[2180] Jabir also describes processes for the preparation of steel, the refinement of metals, and also for dyeing, making varnishes to waterproof cloth, preparing hair-dyes, etc.[2181] Thus, a much vaster repertoire of

[2172] Ibid.
[2173] Ibid.
[2174] H.K. Said: Jabir Ibn Hayyan; in *Proceedings of the First International Symposium for the History of Arabic Science* held in 1976 (Aleppo; 1978), pp. 138-43; at pp. 140-1.
[2175] T. Thomson: *The History of Chemistry* (H Colburn and R. Bentley Publishers; London; 1830), p. 121.
[2176] Ibid.
[2177] Ibid.
[2178] E.J. Holmyard: *Makers*; op cit; at pp. 59-60;
[2179] G.M. Wickens: The Middle East; op cit; p. 113.
[2180] T. Thomson: *The History of Chemistry*; op cit; pp. 121-2.
[2181] E.J. Holmyard: *Makers,* op cit; p. 59 fwd.

accomplishments, which completely contradicts the miserable outlines one finds in most works touching on Muslim chemistry.

Third is the necessity to deviate from the usual distortions, which associate magic, the occult and quacks with Islamic science. Nobody, in truth, did as much as the Muslims to demark science from un-scientific practices that they had inherited from their predecessors. Jabir himself is all too often accused of dabbling in alchemical practices such as transmuting gold and silver, yet, in his prologue to the '*Book of Mercy*,' he says:

> 'I have seen people giving themselves over to the search for the art of (transmuting) gold and silver, in ignorance and without consideration, and I have seen that they are of two classes, the deceivers and the deceived. I am filled with feelings of mercy and compassion (*farahimtu* (Arabic for I showed pity) because they waste their money which God has given them and weary their bodies in a fruitless search . . ., and for the deceived, because in addition to their toils they lose also their souls uselessly for but a slight portion of the goods of the present world.... I have therefore composed a detailed and clear account which no one of the least intelligence can examine with feelings of anger, the profit of which will be obvious, and which will at once free the reader's mind from ignorance and error and save him from losing his money.'[2182]

Ibn Sina, too, in *The Book of Minerals*, attacks the artisans who dye metals in order to give them the outside resemblance of silver and gold. He asserts that fabrication of silver and gold from other metals is 'practically impossible and unsustainable from a scientific and philosophical point of view.'[2183]

Al-Kindi, for his part, wrote specially against so-called transmutation, where alchemists could turn ordinary stones into precious ones. Al-Kindi's work is in fact adequately titled: *Kitab at-tanbih 'al khad al-kimiyyawiyyin* (The Book for Warning Against the Alchemists.) In a bizarre twist, in fact, some have seen in this work evidence that Islamic scientists wrote against chemistry (damned if they did, damned if they did not.) The fact is that, whilst he wrote against alchemy, al-Kindi (just like

[2182] Jabir Ibn Hayyan: *Kitab-al-Rahma* (Book of Mercy); prologue; in D. M. Dunlop: *Arab Civilisation*; op cit; p. 211.

[2183] G. Anawati: Arabic Alchemy, op cit, p.877. Anawati manages to use such reflections as evidence of Islamic attacks on science. Neither Ibn Sina nor Ibn Khaldun attacked science, or chemistry, but the crooked versions of it as their quotations make it very clear.

Ibn Sina) is credited with many works on chemistry, notably his *Kitab al-kimiya fil-itr wat-tas'idat* (The Book of Chemistry of Perfumes and Distillation), which includes 500 recipes for cosmetic products.[2184]

An account of Ibn Sina's views on metals was given by a Al-Jildaki, according to whom:

> 'Avicenna considered that each of the six metals was a distinct species of one genus, just as the plant genus included different species, and the animal genus likewise. And in the same way that it is impossible to convert a horse into a dog or a bird into a horse, or a man into a bird, so it is impossible to convert silver into gold or copper into silver or lead into iron.'[2185]

Ibn Khaldun, too, denounces the frauds who apply on top of silver jewellery a thin layer of gold, and make other manipulations of metals.[2186] For him, the Divine wisdom wanted gold and silver to be rare metals to guarantee profit and wealth. Their disproportionate growth would make transactions useless and would 'run contrary to such wisdom.'[2187]

This Islamic denunciation of 'alchemy' is interpreted by Newman as an obstacle to the advance of technology and applied science.[2188] Thus, Newman says with regard to Ibn Sina's views:

> 'It may be tempting for the modern reader to view Avicenna's rejection of alchemy as a forward looking event that foreshadowed the weaning of chemistry from the 'irrational' or pseudo-scientific' doctrines of alchemy. A closer look will reveal, however, that it was Avicenna, and not the alchemists, who held reactionary views. Avicenna begins his attack with the 'self evident' assertion that natural products are intrinsically superior to their artificial counterparts and that the latter cannot possibly match up to the naturally occurring exemplars of which they are copies. As two modern commentators on the *De congelatione* have remarked, Avicenna would have been on the side of the 'general public [today], who usually imagine that synthetic

[2184] A. Djebbar: *Une Histoire*; op cit; 346.

[2185] See E.J. Holmyard and D.C. Mandeville's translation and edition of Avicennae *De Congelatione et Conglutinations Lapidum* (Paris; Geuthner; 1927), p.7.

[2186] For greater detail on Ibn Khaldun's view of alchemy, see Prof Ead of the Cairo Science Heritage Centre at: http://www.frcu.eun.eg/www/universities/html/shc/index.htm

[2187] G. Anawati: Arabic, op cit, p. 881.

[2188] W. Newman: Technology and Alchemical Debate in the Late Middle Ages; *ISIS*, 80; 1989; pp. 423-45. at pp. 428-9.

indigo, for example, is not veritable indigo, but only very good imitation.'[2189]

Newman adds:

'Whatever the sources of his (Ibn Sina) views, the universal proposition that art is inferior to nature, coupled to the belief that natural species are intransmutable, constituted an attack not on alchemy alone but on the totality of technology and applied science. … The effects of the *De congelatione* were by no means restricted to alchemy but served to crystallize an anti technological bias in many areas.'[2190]

Then, in his conclusion, Newman tells that his purpose was:

'To show that here, in these obscure treatises of the thirteenth century, a propagandist literature of technological development was born.'[2191]

Setting aside Newman's attacks on Ibn Sina for his denunciation of alchemy, Newman also attributes to a culture (Latin) and a century (13th) innovative processes in the science, which in fact preceded them by centuries as has been shown already, and can also be seen in the following, early Islamic contributions without which chemistry would not have emerged into modern science the way, and at the time, it did.

Newman is not alone, however, in misattributing, to the Christian West, 13th century and subsequent chemical breakthroughs, which in fact are owed to Muslim scholars, as the following highlights through a number of instances.

3. Distorted Modern History, and the True Islamic Role in the Rise of Modern Science and Chemical Industries:

Two matters can be brought into focus in the following to highlight historians' distortions of the role of Muslim chemistry: experimentation and the place of Islamic chemistry in the rise of modern chemical industries.

[2189] E.J. Holmyard and Mandeville, in Avicenna De congelatione; op cit; p. 45; n.5.
[2190] W. Newman: Technology; op cit; P. 429.
[2191] Ibid; P. 443.

Experimentation:

Crucial in the advance of chemistry and the rise of modern science, in general, was the advent of experimentation. Modern historians, following Crombie, in their overwhelming majority, cite Grosseteste (1175-1253) as the precursor of experimentation.[2192] Crombie says:

'I have argued at length elsewhere that the contribution of Grosseteste and Roger Bacon and their successors to the scientific tradition of their time was to formulate, from the theoretical empiricism of the twelfth century and the deductive form of scientific explanation learnt from Euclid and from Aristotle's logic, a conception of science that was experimental, mathematical and deductive. From one point of view we can see their work as an attempt to combine the form of scientific thought imposed by Greek geometry and expounded by Plato with the empirical requirements insisted upon by the other great tradition of Greek methodology, that of medicine and of Aristotle.'[2193]

Likewise, Beaujouan says:

'Robert Grosseteste, for instance, did not break with the Platonic and Augustinian tradition: his cosmology of light led him to give first place among the natural sciences to geometrical optics and to the mathematical concepts connected with it. His conception of experimental science owed much to Aristotle, but retained its independence. He was thus in the forefront of a scientific revival[2194] of which the most illustrious exponent was Roger Bacon and of which the most brilliant success was the more or less accurate explanation of the rainbow by Dietrich of Freiberg.'[2195]

These generally held views are fallacies, however. As noted in the preceding chapter devoted to scholarship, experimentation became not just a necessity, but was generalised in the Islamic world from the 8th century onwards. Muslim chemistry, as soon as it emerged, Singer points out, had as its principal features its positive and experimental side, partly

[2192] A.C. Crombie: *Robert Grosseteste and the Origins of Experimental Sciences* (Oxford; 1953).
[2193] A.C Crombie: *Science, Optics and Music in Medieval and Early Modern Thought* (The Hambledon Press, London, 1990.),p.143.
[2194] A.C Crombie: *Robert Grossesteste;* op cit.
[2195] Guy Beaujouan: Motives and opportunities for Science in *Scientific Change;* Edited by A.C. Crombie (Heinemann, London, 1963), pp 219-36; p. 226.

the products of the men of genius who expounded it; whilst any of its philosophical and mystical elements was drawn mainly from Greek sources.[2196] Jabir Ibn Hayyan, for instance, Holmyard notes, was not just acquainted with the operations of crystallization, calcination etc, but also, and above all, he describes them.[2197] He seeks to understand the changes that take place during the processes, stating clearly his aims from the operation, how, for instance, calcination aims at removing impurities from metals, and how such metals are calcinated in different ways.[2198] Jabir, who in the words of Sherwood Taylor deserves honour as one of the few medieval writers who soiled his hands in a laboratory.[2199] In Jabir's own words:

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The ingenious use of unit operations like evaporation, sublimation, filtration, crystallisation, distillation, etc, was an essential and significant aspect of Jabir's experimental advancement.[2201] Amongst his experimental accomplishments are basic lead carbonate, ammonium chloride, preparation of nitric acid and sulphuric acid (the basic ingredients of the first aqua regia used to dissolve gold), etc.[2202]

Around a century after Jabir, Al-Razi (b. 866) went further not just in ridding the science of every mystical aspect inherited from the Greeks, but above all in relying solely on experimental evidence or technical experience.[2203] In his *Secret of Secrets*,[2204] Al-Razi catalogues and describes his experiments, his methodology, the materials he made use of, the apparatus, and the conditions of his experiments.[2205] He insists on the systematic recording and classification of carefully observed and verified

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The same eagerness for experiment was shown by other Muslim chemists such as Maslama al-Majriti of Madrid (d.1007), whose experience with mercury, which he describes in precise detail, indicates that he carried out his own exhortation to be assiduous in practical work.[2210] Maslama's early, accurate observation of the oxidation of mercury, was an experiment which, Holmyard insists, was, in the hands of Lavoisier (late 18th century), behind epoch making developments.[2211]

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[2211] Ibid.

following brief assessment of historical reality proves the complete reverse.

Under the Muslims, chemical technology developed considerably.[2212] Such developments included dyeing, metallurgy of silver, gold, copper, iron, lead, tin and others, tanning, manufacture of inks, paper, and many other products.[2213] Islamic chemistry also bequeathed to modern industry a vast array of products and processes: nitric and sulphuric acids, silver nitrate and potassium, alcohol; tinctures and their applications in tanning and textiles; distillation of plants, of flowers, the making of perfumes and therapeutic pharmacy etc.[2214] Citing *De aluminibus*,[2215] which was composed in Muslim Spain (anonymous,)[2216] Multhauf refers to processes for obtaining chloride of mercury, corrosive sublimate (Hg Cl2), thus marking the beginnings of synthetic chemistry.[2217] Usage of corrosive sublimate in chlorination of materials, Multhauf notes, also marks the beginning of mineral acids.[2218] Heavy chemicals developed through the medieval era via the manufacture of alum out of 'aluminous' rocks (through artificial weathering of alumite), and through crystallization of 'ammonia alum' (ammonium aluminium sulphate).[2219] The most comprehensive study on alum, its extraction, applications, trade, technology associated with, etc, can be found detailed by Singer.[2220] Incidentally, Multhauf is also guilty of the contradictory approach found amongst Western historians, on one hand saying so much on the Islamic contribution to modern chemical industries, and on the other saying that it was European Renaissance which gave chemistry a secure and significant place in science, instead of the Islamic 'alchemy.'[2221]

A number of Muslim chemical, or chemical based, industries and crafts had a dramatic impact on the rise of modern society, culture, and economy. Beginning with the oil industry, naphta, for instance, deriving

[2212] M. Levey: *Early Arabic Pharmacology* (Leiden, 1973), p. 173.
[2213] Ibid.
[2214] Derived from J .Mathe: *The Civilisation of Islam*, tr. by David Macrae (Crescent Books, New York).
[2215] *De aluminibus* was translated into Latin by Gerard of Cremona in Toledo, Spain, in the 12th century.
[2216] Might be by Al-Majriti.
[2217] R.P. Multhauf: *The Origins of Chemistry* (Gordon and Breach Science Publishers; London, 1993).
[2218] Ibid; pp 160-3;
[2219] Ibid; p 339.
[2220] C. Singer: *The Earliest;* op cit.
[2221] R.P. Multhauf: *The Origins*; op cit; p. 351.

from the Arabic *naft*. The oil industry, which was under state monopoly, was widely spread over East-Central Asia (around Baku, and modern day oil fields in Khuzistan), and also in parts of what is now Iraq and the Arab peninsula. A variety of substances were extracted from it: nafta itself, pitch, tar etc, whose usage was for lighting, household energy, sealing of vessels, used as a sealant in house construction, military purposes, and even to cure particular diseases.[2222]

The paper industry also blossomed thanks to its links with chemical industries. The Chinese used the bark of mulberry trees as basic material, the Muslims used linen instead,[2223] which demanded chemical applications and techniques to deliver the same final product, thus opening the way to the concept of substitution. Also according to Ibn Badis, author of *The Book of the Staff of the Scribes and Implements of the Discerning*, paper was dyed after it was manufactured, rather than being coloured before the pulp was put into moulds.[2224]

The glass industry relies on chemical applications (colouring, calcination, etc), and materials (soda, magnesium…). Egyptian glass vessels, for instance, were decorated with lustre, a shiny, sometimes metallic effect achieved by painting copper or silver oxide on the surface of the object, which then was fired at a temperature of about 600°C (1112°F.) in reducing conditions.[2225] In his *Secret of Secrets*, already referred to, Al-Razi, other than classifying natural substances, also adds a number of artificially obtained ones such as lead oxide, caustic soda, and various alloys.

It is worth adding here this practical instance of how to make hard soap according to al-Antaki:

> 'Take one part of al-qali, and half a part of lime. Grind them well and place them in a tank. Pour five times water and stir for two hours. The tank is provided with a plug-hole. When the stirring is stopped and the liquid becomes clear, the hole is opened. When the water is emptied plug the hole again and pour water and stir, then empty, and so on until no taste is left in the water. This being done while keeping each water separate from the other.
>
> Then take from the pure oil ten times the quantity of the first water and place on a fire. When it boils feed it with the last water little by little. Then the water before the last until at last you feed

[2222] A. Djebbar: *Une Histoire;* op cit; pp. 346-7.
[2223] D. Hunter: *Paper Making Through Eighteen Centuries* (Burt Franklin; New York; 1971), p 156.
[2224] T. Walz: Writing materials, in *The Dictionary of the Middle Ages*; op cit; Vol 12; at pp 697-9.
[2225] D. Whitehouse: Glass; in the *Dictionary of the Middle Ages*; op cit; vol 5; pp. 545-8.

it with the first water. Then it becomes like dough. Here it is ladled out [and spread] on mats until it is partially dry. Then it is cut and placed on *nura* [slaked lime]. This is the finished product and there is no need to cool it or wash it with cold water while cooking. Some add salt to the al-qali and lime in half the quantity of lime. Others add some starch just before cooking is over. The oil can be replaced by other oils and fats such as the oil of carthamus.'[2226]

The discovery of inorganic acids has had a great impact on the development of modern chemistry. These were the products of the distillation of alum, sal ammoniac (chloride of ammonia), saltpetre (potassium nitrate) and common salt in various proportions, as well as vitriol.[2227] Vitriol was a term used in early times for hydrated sulphate crystals, in later times, it became synonymous with sulphuric acid.[2228] These various acids produced during chemical experiments became valuable agents in a number of industrial processes.[2229] Jabir's *Sanduk al-Hikma* (The Chest of Wisdom) *de inventione veritalis* (in Latin), contains the first clear account of the preparation of nitric acid and aqua regia:

'Take of vitriol of copper one pound, of Saltpeter ½ a pound, of Yemen alum ¼ pound. Extract the water (that is distil) with an alembic at dull red heat. The distillate becomes much more active if you add a quarter pound of *sal ammoniacum,* for the liquid then dissolves gold, sulphur and silver.'[2230]

The distillation will yield nitric acid. When sal ammoniac is added to this, hydrochloric acid is formed and the mixture becomes the solvent used by the goldsmiths and chemists.[2231]

Sulphuric acid was first described in Islamic writing in the Jabirian corpus, and it can be made by distilling vitriol or alum, or by the combustion of sulphur.[2232] Al-Razi, too, in one of his recipes called it 'water of distilled alum,' and he used it as one of the reagents which he prepared beforehand and kept for use in his chemical work.[2233]

[2226] A. Y. al-Hassan, and D. R. Hill: *Islamic Technology* (Cambridge University Press, 1986), pp. 150-1.
[2227] D.R. Hill: *Islamic Science and Engineering* (Edinburgh University Press; 1993), p. 88.
[2228] Ibid.
[2229] Ibid.
[2230] In C. Singer: *The Earliest;* op cit. p. 61.
[2231] Ibid.
[2232] D.R. Hill: *Islamic Science*; op cit; p. 88.
[2233] Ibid.

Hydrochloric acid was known as spirit of salt. Al-Razi gives the following recipe:

'Take equal parts of sweet salt, bitter salt, Tabarzad salt, Indian salt, salt of al-qali and salt of urine. After adding an equal weight of good crystallised sal ammoniac, dissolve by moisture and distil the mixture. This will distil over to give a strong water which will clave stone instantly.'[2234]

In other Islamic manuscripts, there are recipes in which sal ammoniac and vitriol are distilled together.[2235]

Islamic industrial chemistry extended to many other applications, processes, and products, some of which are succinctly outlined here. Again, back to Jabir who gives a description of a furnace for melting metals, and mentions the vessels in which such processes were conducted.[2236] He was acquainted with crucibles, and even describes the mode of making cupels, nearly similar to those used at present.[2237] The process of cupellating gold and silver, and purifying them by means of lead, is given by him minutely and accurately: he calls it cineritium, or at least that is the term used by the Latin translator.[2238] His noteworthy applications also include refinement of metals, preparation of steel, dyeing of cloth and leather, varnishes to waterproof cloth, and protect iron from rust and corrosion, using manganese dioxide in glass making, using of iron pyrites for writing in gold, distillation of vinegar to concentrate acetic acid, etc.[2239]

Al-Razi, too, describes several industrial applications, including the use of alum, notably on mercury in the amalgamation of gold and silver, in the calcination and amalgamation of copper and lead etc.[2240]

Al-Majriti, in his *Rutbat Al-Hakim* (The Rank of the Wise), amongst other things gives formulae and instructions for the purification of precious metals.[2241]

In the relationship between chemistry and pharmacy, the Muslims constantly developed their material medica.[2242] These improvements, as

[2234] Ibid; p. 89.
[2235] Ibid.
[2236] T. Thomson: *The History of Chemistry;* op cit; p. 122.
[2237] Ibid.
[2238] Ibid.
[2239] H.K. Said: Jabir Ibn Hayyan; op cit; p. 140.
[2240] C. Singer: *The Earliest;* op cit. p. 51.
[2241] M. A Kettani: Science, op cit, p. 79.
[2242] M. Levey: *Early Arabic Pharmacology;* op cit; p. 173.

Thomson points out, were made by Muslim scholars, for no notice is taken of these processes by any of the Greek or Roman writers that have come down to us.[2243] We find them minutely described by the earliest chemical writers among the Muslims.[2244] Al-Razi, for instance, used chemical compounds for medical purposes, and following a scrupulous methodology.[2245] For internal use, al-Razi recommends several substances related to the so called 'mineral kingdom,' such as camphor, lapis lazuli (composed of silica, alumina, carbonate and sulphate of lime and other minerals), concretion of bamboo (calcinated ivory composed of silica potash and lime salts together with organic material), vitriols (recommended in small quantities) etc...[2246] Al-Zahrawi (d.1013) in his *Liber servitoris* informs the reader how to prepare 'simples' from which were compounded the complex drugs then generally used.[2247] He devotes one third of the treatise to the preparation of chemical compounds and the purification, calcinations or washing of raw material of mineral origin, all of which are primarily intended for medicinal use.[2248] Al-Zahrawi gives methods of preparing litharge, white lead, lead sulphide (burnt lead), burnt copper, cadmia, marcasite, yellow arsenic and lime, vitriols, salts, natron etc; whilst his distillation as a means of preparing drugs, was the most significant aspect of all in the view of Sherwood Taylor.[2249] Al-Muwaffaq (fl. 10th century) wrote *The Foundations of the True Properties of Remedies*, which amongst others describes properties of arsenious oxide and silicic acid. He made distinctions between sodium carbonate and potassium carbonate, and drew attention to the poisonous nature of copper compounds, especially copper vitriol, and lead compounds. He also mentions the distillation of sea-water for drinking.[2250]

[2243] T. Thomson: *The History of Chemistry*; op cit; p. 123.
[2244] Ibid.
[2245] C. A. Ronan: The Arabian, op cit, p. 239.
[2246] From Al-Razi: *Kitab al-Hawi fi'l tibb*, in S.K. Hamarneh: Climax of chemical therapy in 10th century Arabic Medicine; in *Der Islam;* vol 38 (1963) pp. 283-8. at p. 285.
[2247] F. Sherwood Taylor: *A History of Industrial Chemistry* (Heinmann, London, 1957), pp 140-1. Sherwood Taylor generally tends to refer to any Islamic breakthroughs in the shortest wording possible.
[2248] S.K. Hamarneh: Climax of chemical therapy; op cit; p. 287.
[2249] F Sherwood Taylor: *A History*; op cit; p.141.
[2250] In E.J. Holmyard: *Makers*, op cit, at p.68.

4. Learning About and From Islamic Chemistry:

The Western interest in, and knowledge of, Muslim chemistry was intensified by the 12th century translations from Arabic into Latin carried out in Toledo. Amongst the translators was Robert of Chester who translated *Liber de compositione alchemise,* whilst Hugh of Santalla made the earliest Latin translation of *lawh azzabarjad* (The Emerald Table). Alfred of Sareshel translated the part of Ibn Sina's *Kitab al-Shifa* (The Book of Healing) that deals with chemistry.[2251] It is, however, as usual, the Italian, Gerard of Cremona, who made the more valuable translations, such as of Al-Razi's *De aluminibus et salibus*, whose Arabic original is preserved.[2252] The many versions of this work had a decisive influence on chemical developments in the West, more generally on mineralogy.[2253] A later translation was of *Kitab al arais wa atayib al-nafais* by al-Hasib, a treatise on precious metals and perfumes written in 1301. The most interesting chapter is the final one on the knowledge of the art of mosaics, including materials to employ, solutions to prepare, the manipulations used for the manufacturing of the product, all precise and accurately listed.[2254] *Kitab al arais wa atayib al-nafais* can be found in its original, but also in a German translation.[2255]
Islamic pharmacology with its chemical content received a good deal of interest on the part of European translators. A treatise by Al-Maridini of Baghdad and Cairo was translated as *De Medicinis universalibus et particularibus*, and that of Ibn al-Wafid of Spain was made into *the Medicamentis simplicibus*'.[2256] Peter of Abano (1250-1316) translated and added a supplement to the work of al-Maridini under the title *De Veneris.*

The medical aspects of Muslim chemistry have recently attracted the interest of both Meyerhof[2257] and Levey.[2258] The main subjects of such Muslim pharmacy, according to Levey, are:

[2251] See. G. Sarton: Introduction; op cit; vol 2 for translations of Muslim science into Latin and other languages.
[2252] J. Ruska: *Das Buch; op cit;* mentioned in R. Halleux: The Reception of Arabic Alchemy in the West, in the *Encyclopaedia* (Rashed ed) op cit, pp 886-902, at p. 892.
[2253] R. Halleux: The Reception, op cit, p. 892.
[2254] A. Mieli: *La Science Arabe*; op cit; p.157
[2255] In H. Ritter, J. Ruska, F.Sarre, R. Winderlich: *Orientalische Steinbucher und persische fayence-Technik* (Istanbul, 1935).
[2256] M. Meyerhof: Science and medicine, in *The Legacy of Islam,* (T. Arnold and A. Guillaume); pp 311-55; at pp 331-2.
[2257] M. Meyerhof: 'Esquisse d'histoire de la pharmacologie et de la botanique chez les Musulmans d'Espagne,' *al-Andalus* 3 (1935), pp. 1-41.

1) Medical formularies which include many kinds of compound drugs, pills, pastilles, powders, syrups, oils, lotions, toothpastes...
2) Books on poisons.
3) Synonymatic: treatises, in which are found lists of simples usually in alphabetical order to help the reader to identify the drug in other languages.
4) Tabular, synoptic texts, whereby long texts are turned into tabular work for quick usage, and abstracts made of some treatises for the same purpose.
5) Lists of materia medica which include therapeutic considerations and opinions of various writers on the subject, preparations of the drugs and descriptions..
6) Substitute drugs in case one drug for whatever reason was not available, a substitute was provided.
7) Works on medical specialities available either as separate treatises or as sections of large encyclopaedias of medicine.[2259]

Many aspects of Islamic chemistry have been dealt with by Holmyard, Kraus, and above all Ruska. Much of such material, however, is only available in German.[2260] Despite such focus, there is still no comprehensive work on Islamic chemistry by any single author. Other than lack of interest amongst today's scholarship, in particular, practical obstacles stand in the way of this task. Western scholars, as De Vaux points out, are hampered by the fact that many aspects of Islamic chemistry, notably industrial technology, remain too technical for the Arabist to comprehend.[2261] For the chemist, it will be Arabic (the language) that will be hard to comprehend. Another problem is difficult access to manuscripts; Sherwood Taylor points to hundreds of Islamic works on chemistry, and only very few are translated into a European tongue.[2262] The poor translation of manuscripts already 'edited or translated' also stands in the way. Apart from Jabir, and al-Razi, the contribution of Muslim chemists has been neglected. Apart from a few extracts on al-Majriti, little is known of the Muslim-Spanish chemical

[2258] M. Levey: *Early Arabic Pharmacology;* op cit.
[2259] Ibid; pp 68-70.
[2260] See for instance:
-P. Kraus: *Jabir Ibn Hayyan;* Textes choisis (Paris, Cairo, 1935).
-J. Ruska: 'Al-Rasi; op cit.
-J. Ruska: 'Die Alchemie des Avicenna; op cit.
-J. Ruska: 'Die Alchemie ar-Razi's'; op cit.
-J. Ruska: *Das Buch der Alaune; op cit.*
[2261] Carra De Vaux: *Les Penseurs;* op cit; p. 391.
[2262] F. Sherwood Taylor: *A Short History;* op cit; p.81.

tradition. Yet, as Holmyard insists, the study of Muslim chemistry in Spain is highly crucial due to the fact that it was from that country that Muslim chemistry passed to Europe.[2263]

Final Words:

Nothing captures the scope and nature of Islamic chemistry more than these lines by Jabir, on which to end this chapter. He defines chemistry as:

> 'A branch of natural science, for it investigates mines and the manner in which, by the action of fire, metals are produced in them, since men desire by artificial means to imitate nature. Everyone, indeed, who knows anything of [natural] philosophy realises that the art [of chemistry] imitates nature and models itself on her. Now, how can a man imitate a thing of which he knows nothing? As for those for whom this book is written, they hold steadfastly to the science therein and know its high place in philosophy.
> He who studies chemistry must know that there are ten conditions to be observed for its successful practice. These are: 1. the operator should know the reason for performing each operation; 2. the instructions must be properly understood, since every art has its own technical language; 3. the impossible and profitless should not be attempted; 4. time and reason must be carefully chosen; 5. it is best for the laboratory to be in a secluded place; 6. the chemist must have trusty friends; 7. he must also have leisure to conduct his experiments; 8. and patience and reticence; 9. and perseverance; 10; he must not be deceived by appearances into bringing his operations to too hasty a conclusion.'[2264]

[2263] E.J. Holmyard: Maslama; op cit; p. 293.
[2264] Jabir Ibn Hayyan: *Book of Knowledge of the Divine Art and Philosophical Wisdom*; no 51; in E.J. Holmyard: Jabir Ibn Hayyan; op cit; p. 55.

TECHNOLOGY AND ENGINEERING

Winder notes that in the:

> 'Standard, original' *The Legacy of Islam* (edited by T. Arnold and A. Guillaume), a work of some four hundred pages that is still less than half a century old, the entire pre-modern legacy of Islamic technology, mechanics, and engineering is summarized in twelve lines.'[2265]

Winder is not alone in noting this neglect, which affects all aspects of Islamic Engineering and technology. In civil engineering, for instance, Smith states:

> 'Historians of civil engineering have almost totally ignored the Moslem period, and in particular historians of dam building, such as there have been, either make no reference to Moslem work at all or, even worse, claim that during Umayyad and Abbasid times dam building, irrigation and other engineering activities suffered sharp decline and eventual extinction. Such view is both unjust and untrue.'[2266]

Similarly, Pacey notes that it is often said that hydraulic engineering 'made little progress under the Muslims,' and that the latter's achievements hardly evolved beyond the Greek or Roman's; whilst in truth, the Muslim contribution in mechanical and hydraulic technology is enormous.[2267]

On mechanical technology, Hill observes:

> 'Of all the fields in which the Arabs have made significant contributions to the progress of civilization, that of mechanical technology has been the least studied. As a result, historians studying the technologies of Europe and the Far East have been seriously handicapped by an inability to make comparisons with scholarly material on the Middle East.'[2268]

[2265] R.B. Winder: Al-Jazari, in *The Genius of Arab Civilisation; Source of Renaissance*; ed J.R. Hayes (Phaidon; 1976), p. 188.
[2266] N. Smith: *A History of Dams* (The Chaucer Press, London, 1971).
[2267] A. Pacey: *Technology in World Civilization, a Thousand Year History* (The MIT Press, Cambridge, 1990), at p.8.
[2268] D.R. Hill: Mechanical Technology, in *The Genius;* op cit; pp 175-87 at p. 175.

This neglect is found in the overwhelming majority of works on the history of engineering and technology. Seeking, seemingly, to address this deficiency, Cardwell's Fontana history of technology opens on the first page of the preface with:

> 'In order to rectify this situation (of inadequate presentation of the history of science) that the Fontana History of Science has been set up. Each of these wide ranging volumes examines the history, from its sources to the present of a particular field of science.'[2269]

One obviously delights in this observation, yet, reading through the work, of a few hundreds pages, all Cardwell has to say about China or Islam are a couple of words; and that the Muslims merely passed on inventions made by others to Europe.[2270] Contradicting what was stated in the preface, Cardwell admits that he can 'hardly do more than briefly mention the achievements of the Chinese, Indian, and Islamic civilisations.'[2271] But to his credit, Cardwell raises the crucial point:

> 'It is regrettable that there is still no study of Arab science and technology comparable to Dr Needham's monumental work (on China). This is the more surprising in view of the great wealth of certain Arab nations.'[2272]

In agreement with Cardwell, until it is done, the same misrepresentations as those noted above by Smith, Pacey, Hill and others will persist.

When Muslim technology and engineering is addressed in some works, or as here by some web-sites, it still betrays serious deficiencies as found at the site by Paul J. Gans at http://scholar.chem.nyu.edu/~tekpages.html (As seen in the years 1999-2000.)

This site considers some Islamic contributions such as the manufacturing of paper and soap, the construction of windmills, the invention of spectacles, etc, which is an improvement in comparison to most works of any sort that deal with this science. The site, however, betrays the deficiencies found in most works on the subject, namely:

a) A lack of reference to original Islamic sources notably those of the Banu Musa and Al-Jazari, which is not understandable as there have been translations by Hill of such works.

b) A lack of reference to good secondary sources in German by Wiedemann, in particular,[2273] and those in Spanish.

[2269] D. Cardwell: *The Fontana History of Technology* (Fontana Press; London; 1994).
[2270] Ibid; p.30.
[2271] Ibid; p. 11.
[2272] Note 6; p.515.
[2273] E. Wiedemann:

c) An excessive reliance, instead, on modern historians who are the least inclined towards Islamic science. Hence excessive reliance is placed upon Gimpel,[2274] Clagett,[2275] and above all on Lynn White Jr,[2276] whose writings have tended to narrow technological achievements to Western Christendom alone. This particular role of Lynn White in distorting the history of the science is examined herein.

1. Lynn White Jr and his Role:

Lynn White (JR) is considered the main 'authority' on the history of technology, followed and referred to by nearly all historians of technology and sciences. Lynn White's views are reiterated in many forms but bear the same substance as seen in the following extracts.[2277] He states:

> 'The earlier record of technology around the globe is scattered and often lacking in continuity; it recounts a generally slow accumulation of isolated specific inventions, their spread and elaboration. But in the Middle Ages, in Europe alone, invention became a total and coherent project. From the later Middle Ages onward, world technology was increasingly European technology....'[2278]
>
> 'By the early fourteenth century, then, Europe showed not only an unmatched dynamism in technology, it also arrived at a technological attitude towards problem solving which was to become of inestimable importance for the human condition. The

-*Beitrage zur Geschichte der Natur-wissenschaften. X. Zur Technik bei den Arabern.* Erlangen, 1906.
-'Zur mechanik und technik bei der Arabern' in *Sitzungsherichte der physikalisch-medizinischen Sorietat in Erlangen* (38), (1906).
[2274] Jean Gimpel: *The Medieval Machine* (Pimlico, London, 1976).
[2275] M. Clagett: *The Science of Mechanics in the Middle Ages* (Madison University of Wisconssin Press; 1959).
[2276] Lynn White Jr: *Medieval Technology and Social Change* (Oxford, 1964).
Lynn White Jr: 'Technology in the Middle Ages,' in *Technology in Western Civilisation*, Vol 1, edited by M. Kranzberg and C.W. Pursell Jr (Oxford University Press, 1967), pp 66-79.
L White Jr: Cultural Climates and Technological Advance in the Middle Ages; *Viator*; 2; pp 171-201.
Lynn White Jr: The Act of invention; *Technology and Culture*, Vol 3; pp 486-500.
[2277] Derived from Lynn White Jr: Cultural Climates; op cit; pp. 172 ff.
[2278] Ibid; pp. 172-3.

> profound contrast between this aspect of the Occident and the relative passivity toward technology in the Near East is the more significant... The fact that in the time of Saint Thomas Aquinas labour saving machinery was little developed in the Near East and concern for invention was minimal, whereas in the West a new sort of engineering was being pursued with an enthusiasm amounting to passion, helps us to understand why the Occidental third of the Middle Ages generated what we call the modern world.'[2279]

And:

> 'In the medieval East, whether Byzantine or Islamic, technological innovation was not considered important.'[2280]

And finally:

> 'In the twentieth century, new technology is composed so largely of engineering applications of scientific discoveries that we tend to assume a similar relation in the past. In fact, however, until a little more than a century ago there was small connection between science, which was a theoretical effort to understand nature, and technology, which was an empirical attempt to use nature. For nearly five hundred years the world's greatest scientists wrote in Arabic, yet a flourishing science contributed nothing to the slow advance of technology in Islam. By the late thirteenth century the scientific movement in the West, which had begun in the eleventh century with a wave of translations from Greek and Arabic, had seized the global primacy that it still holds.'[2281]

Thus, primarily, according to Lynn White, technology is a Western concept, explaining today's Western superiority. Which is hardly a uniquely held idea, but is shared by most Western historians, Parry, for instance, concludes his long introductory note on the 'Age of Reconnaissance' with the following:

> 'A technological attitude to knowledge, an extreme readiness to apply science in immediately practical ways, eventually became one of the principal characteristics which distinguish Western civilisation, the civilisation originally of Europe, from other great civilised societies. The unprecedented power which it produced eventually led Europe from Reconnaissance to world wide conquest, and so created the world of yesterday, much of which was governed by Europeans, and the world of today, almost all of

[2279] Ibid; pp. 173-4.
[2280] Ibid; pp. 177.
[2281] Ibid; pp. 179.

which has accepted European technology and European techniques of government, even if only to escape from actual European rule.'[2282]

Lynn White, more than all other historians, supplies this theory of Western technological supremacy with its intellectual foundations. Lynn White's theory, however, is flawed in many respects. These flaws are enumerated here.

First and foremost, on a wider level, Lynn White's views, even if certainly he did not intend them, go in the same direction in reinforcing the views that no entity other than the Western is capable of anything of worth. This view is certainly expressed by many other scholars in formal, academic veneer, and relies on the academic nitty gritty of referencing etc, but, whether intended or not, it is the very academic foundation of, and it feeds, more extreme strands in society. This pursuit by apologists under diverse guises that the West is the mother of all that is good on earth is woefully misguided. This author believes that passionately defending one's culture is very different from condemning the others as useless or inadequate. The latter attitude creates a sense of superiority to others, which can have grave repercussions.

The theory of Western superiority has serious flaws. A major flaw common to nearly all Western historians of science, and specifically those of technology, is their claim to be dealing with the subject on a universal basis, and yet, they only focus on one specific culture (the Western.) Any look at history from a truly universal basis finds that all groups and entities contributed in large measure to our modern civilisation. Technological breakthroughs from China, for instance, as dealt with by Needham, a rare work of the sort, show the crucial Chinese contribution to nearly all of our modern technology.[2283]

The second problem has to do with referencing, whereby Western historians assert their views by referencing to, and citing, similarly minded historians. White, Gimpel, Bradford Blaine, and so on, refer to each other endlessly and build the history of technology from their own shared perspective. This is incomplete history. Especially when such authors also deliberately suppress references to other sources (i.e

[2282] J.H. Parry: *The Age of Reconnaissance* (Weidenfeld and Nicholson; London; 1966), p.16.
[2283] J. Needham: *Science and Civilization in China;* op cit.

Wiedemann),[2284] which have a different understanding of the subject. Lynn White, in particular, also repeatedly backs his views by referring to *Technology and Culture*, a review he himself established, and he also refers to himself to back certain facts.[2285] If this latter tactic was done within a large book that also explores opposite views, it would be acceptable; but done in a short space, i.e an article, and if repeated, it distorts the picture considerably.

Worse, is when Lynn White backs his theories with weak evidence as when he says:

> 'About 1235 Villard of Honnecourt, and in 1269 Peter of Maricourt, independently inform us that many men are arguing and labouring to the point of exhaustion to produce perpetua mobilia.'

Through this quotation, Lynn White seeks to prove that technicians in large numbers 'began to consider systematically all the imaginable ways of solving a problem.'[2286]

This is weak evidence, though. Honnecourt and Maricourt informing us is hardly strong evidence to support the picture of a generalised striving for technology as White asserts. It hardly matches evidence provided by something quantifiable, or a change of the sort of new regulations, laws, or rise in the status of artisans in society, etc.

White also uses the technique of picking one isolated statement by a contemporary Muslim to generalise it into a negative image of Muslim society, as here with regard to Al-Jazari saying, 'That the notion of mills driven by the wind is nonsense, the wind is too fickle to power such a machine.'[2287]

This hardly constitutes proof of Muslim hostility to wind power as White implies. Al-Jazari's reported opinion conflicts with the abundance of facts proving the very opposite, as windmills, as will be explored further on, were widely used throughout the Islamic world.

Lynn White cites Peter of Maricourt recurrently in his role in the development of a magnetic instrument, but that distorts reality, once more, because Lynn White omits crucial facts. He fails to reveal that Peter of Maricourt (Petrus Peregrinus) stayed in the Islamic East during the crusades, which is absolutely central to trace some of his influences. Peter of Maricourt, indeed, as Erbstosser notes, brought knowledge of magnetism and the compass back to France from the Orient, and in 1269

[2284] Or only cite them when they give support, intended or not, to their point of view as can be found in note 23; p. 76 in Lynn White Jr: Cultural climates; op cit.
[2285] i.e note 10. p. 173; note 42; p. 179 in Lynn White Jr: Cultural; op cit.
[2286] Note 7 p. 173; L. White: Cultural; op cit.
[2287] Note 23; p. 176; in L. White: Cultural; op cit.

wrote a treatise about magnetism in which an illustration of a compass appears for the first time.[2288] By removing this crucial fact, Lynn White distorts the picture thoroughly.

The third major weakness of White, and most modern Western historians of science, relates to the sudden appearance of hundreds of changes in Western Christendom in the 12th-13th centuries. If one takes at random the changes that suddenly took place in this short period, by just focusing on one of Lynn White's articles (Cultural Climates and Technological Advance in the Middle Ages),[2289] in just one page (173), one finds countless examples of them: the rise of technicians; the solving of the problem of arrow wounds; the introduction of the compass; the discussion of weight driven clocks; the invention of the sand glass; Bacon pondering transportation and confidently predicting the advent of the automobile, submarines, etc. Then, another two pages, (pp. 174-5), and another crowd of sudden technological breakthroughs, including: the invention of eye glasses, a new technological attitude; labour saving methods; the birth and rise of windmills, etc. The question one would surely ask is: why did not Lynn White ask himself: what happened in such crucial short period for all such things to appear suddenly? How is it that Western Europe, formerly locked in darkness for centuries, incapable of inventing anything, suddenly, out of nowhere, burst with such genial spirit of inventiveness out of nothing? And if Lynn White had looked at other subjects, architecture, trade, pharmacy, poetry, universities, hospitals, etc, he would have found exactly the same sudden outburst of genius, there, too, and in the same period precisely. Surely there is an oddity here. One or two sudden changes make sense; or many changes over a long stretch of time, based on long- established, gradual transformations, also make sense. Sudden changes, out of nowhere, or more precisely out of barbarism, in their hundreds, complete, thorough, near perfected, in their forms and functions, make no sense at all. It is as if a Muslim country today suddenly discovers lasers, cures all forms of cancer, builds advanced weaponry, sends spaceship galore into the sky, all without the preceding trials and failures, and claims it made no borrowing from the West, the Chinese or the Russians. This would make no sense to any reasonable person. The same is true with all these miraculous, hundreds of changes, that suddenly took place in the West out of no precedent in the 12th–13th centuries. Some would answer that such miraculous developments in Western Christendom in this period were due to the

[2288] M. Erbstosser: *The Crusades;* op cit; p. 188.
[2289] L White Jr: Cultural Climates; op cit;.

recovery of Ancient Classical heritage that had been lost before then for centuries. This, however, can be easily checked by just comparing these changes with their Ancient antecedents and it is found that they neither resemble nor relate to each other. Moreover, there is no Greek antecedent in paper making, castle defences, steel making, etc. Thus, all such changes came from elsewhere, and it is important to discover where is this 'elsewhere,' that in the 12th-13th century came into contact with the Christian West. And that elsewhere, precisely, is the Islamic world, brought into firm contact with the West in the 12th-13th century, through the crusades (1095-1291) and the conquest of Spain by the Christians (late 11th-13th century).[2290]

Fourth, Lynn White's views are wrong because historically they include serious factual flaws. To take some instances, he says:

> 'Since arrow wounds were then a medical problem, about 1267 Theodoric, successively bishop of Bitonto and Cervia, in his treatise on surgery noted that for the extraction of arrows *'quotidie enim instrumentum novum, et modus novus, solertia et ingenio medici invenitur.'*[2291]

Contrary to what Lynn White asserts here, there is nothing new in either Theodoric's instruments or methods. Two centuries before Theodoric, Al-Zahrawi (940-1013), a surgeon of Muslim Spain wrote *al-Tasrif,* known in Latin as *liber servitoris,* which includes many surgical instruments, which Al-Zahrawi devised and constructed, and a number of surgical procedures.[2292] He explains with the aid of drawings the use of such instruments, and surgical operations in great detail. A whole chapter (46) includes descriptions and illustrations of instruments for incising and perforating. Al-Zahrawi devotes to the particular matter of extraction of arrows an extensive amount of attention. Al-Zahrawi also describes the wounds from arrows; how to deal with each wound according to its location in the body; under what conditions the wounded should person not be operated upon; he narrates his own experiences of arrows he had himself

[2290] See, for instance,
-C.H. Haskins: *Studies in the History of Mediaeval Science* (Frederick Ungar Publishing Co. New York. 1967 ed).
J. Harvey: The Development of Architecture, in *The Flowering of the Middle Ages*; ed J. Evans (Thames and Hudson; 1985), pp. 85-106.
-H. Prutz: *Kulturgeschichte der kreuzzuge* (Berlin, 1883).
[2291] Chirurgia 1.22, appended to Guy de Chaulliac, ars chrurgica (Venice 1546) fol 143 in L. White: Cultural; op cit; p. 173.
[2292] M.S. Spink and G.L. Lewis: *Abulcasis on Surgery and Instruments* (The Wellcome Institute, London, 1973).

extracted from patients, and so on and so forth.[2293] There was thus nothing new in either methodology or instruments in the hands or head of Theodoric, and had Lynn White enquired a little, he would have come across two crucial facts, the first that the surgical part of Al-Zahrawi's *Al-tasrif* was translated into Latin by Gerard of Cremona in the 12th century, and the second, that it was not uncommon for 13th century, and subsequent Western Europeans to borrow from it. For instance, William of Saliceto (1201-77), Italian surgeon, commonly known as Saliceto or Salicet, and as Placentinus,[2294] was a source for the Frenchman Lanfrank. Guy de Chauliac (1300-68) notes how Lanfrank 'wrote a book containing little else than what he got from William but changed the order;' Saliceto's work itself primarily is based on Al-Zahrawi.[2295]

A second instance of historical fallacy by White is when he tells us:

> 'Despite assertions to the contrary regarding Jativa in Valencia in the middle of the twelfth century,[2296] there is no proof that the production of pulp for paper was ever mechanised in Islam. In startling contrast, the first paper factory known to us in the West- it was already in operation by 1276 near Fabriano[2297] was a mill, using water power for pulping. So, likewise was the second, in 1280 at Jativa,[2298] now under Aragonese rule.'[2299]

Setting aside the evidence of use of water powered mills, and the use of water power to beat the pulp in the Islamic world, which will be looked at further on under the appropriate heading, focus here is on the incorrect conclusion reached by White, that in Jativa, under the Muslims there was no technology, but in the same place, under Aragon Christian rule, technological knowledge was developed. White could not ignore the latter point because there is evidence for it, which he himself refers to. What he omits, though, is a very crucial point, which is: if the technical skills in Aragon belonged to the Christians rather than to the Muslims why is it we find in official documentation of the crown of Aragon constant emphasis on keeping Muslim artisans. Muslim masters of skills were allowed to retain their functions and serve the new crown, and amongst them were paper makers.[2300] Christian rulers made concerted efforts to keep Muslim

[2293] Ibid.
[2294] D. Campbell: *Arabian Medicine*, op cit; p.133.
[2295] Ibid.
[2296] C. Singer et al: *A History of Technology;* 5 Vols (Oxford at The Clarendon Press, 1956); vol 3; p.412.
[2297] A. Zonghi: Le antiche carte fabrianesi; in *Monumenta chartae papyracea historiam illustrantia*; ed. J. Labarre; 3 Hilversum; (1960); p. 114.
[2298] A. Blanchet: Essai sur l'histoire du papier et de sa fabrication (Paris; 1900), pp. 52-3.
[2299] L. White: Cultural; op cit; p. 179.
[2300] N. Smith: *A History of Dams* (The Chaucer Press, London,1971), p .103.

owned industries going, particularly those crafts deemed to be Islamic specialities.[2301] Jaime of Aragon encouraged the continuity of the paper industry in Jativa and supported it by forbidding the making of paper by Muslims elsewhere in the kingdom of Valencia.[2302] Thus, there is plenty of evidence to show that, contrary to the fallacious writing of Lynn White, skills and technology belonged to the Muslims, and it was they who passed it on to their Christian successors.

As Lynn White's and his followers' argument rests on shaky ground, their reaction to anything or anyone countering their views had to be hostile. This is well evidenced in Lynn White's and his followers' violent onslaught on Singer, when he, Singer, assisted by Hall and Holmyard, completed the edition of the large '*History of Technology,*' in five volumes. Looking at the technological contrasts between East and West, Singer, Hall and Holmyard demonstrated how in skill and inventiveness the East was much superior to the West for centuries (9th-15th), and that it was from the East that most technological ideas came to the West.[2303] Their view is more precisely expressed in this lengthy extract:

> 'It must be further remembered that there are certain great technological movements, within the period under review, which cannot be brought out either in time-charts or even in the narrative that makes up this volume. Discussion of the development of certain such movements must necessarily be spread over two or more of these volumes. This matter needs some further treatment, because conventional history has distorted the picture that this work seeks to convey.
>
> Ever since the fifteenth-century revival of learning, the debt of the Western world to Greece and Rome has been stressed in our whole educational system.... This foreshortened history laid an undue stress on the Greco-Roman heritage of our own civilization and necessarily ignored our even deeper debt to the great civilizations of the Near East on which those of Greece and Rome were themselves built... The spirit of this outdated tradition has delayed the development of a philosophical and integrated view of the course of our civilization in general and of our technology in particular.
>
> The present volume does not attempt to rewrite the history of two thousand years, but with reference to technology the reader must

[2301] T.F. Glick: *Islamic and Christian Spain;* op cit p. 223.
[2302] Ibid.
[2303] C. Singer et al edition: *A History of Technology;* Vol II; op cit.

be reminded of certain necessary major adjustments of conventional historical perspectives. For remains of the old time-scale still linger, well enough concealed, in elementary history books and, moreover, still form a large part of the educational background in the so-called humane studies…..

We are accustomed to think of post-Roman history as centred on Europe and especially on north-west Europe, now for centuries its technologically most developed part. Europe, however, is but a small peninsula extending from the great land mass of Afrasia. This is indeed its geographical status and this, until at least the 13th century A.D., was generally also its technological status. In skill and inventiveness, during most of the period treated in this volume, the Near East was superior to the West, and the Far East perhaps superior to both. During most of the period discussed in this volume the cultures and civilizations of several peoples of the Far and Middle East were at their highest. Many technological ideas came thence to Western Europe. Some of them came direct through the open barbarian frontier of Eastern Europe. Most came either through the Byzantine Empire, which for a thousand years was the wealthiest and most civilized Christian state, or through Islam which, from the 9th century till the 14th, was technologically far superior to Western Europe.

During the millennium roughly extending from 500 to 1500, the relations of East and West were very different from those with which we are today familiar. Thoughtful men who have been nurtured in any of the great and ancient civilizations of the East-Chinese, Indian, Japanese, Islamic, or other-whatever they may think of us and of our ways of life, however anxious they may be for freedom from Western control, nevertheless accord to the Western industrial system and especially to the technology on which it is based, the sincerest form of flattery. Though they often forget the intimate relation of that technology to the social evolution and political history which are its roots, yet they are not far wrong in supposing that industrial techniques-especially those of mass-production-form the foundations of Western superiority.

During most of the period under discussion here, the boot was- on the other foot. For nearly all branches of technology the best products available to the West were those of the Near East, at first those from the Byzantine Empire and later also from the Islamic Caliphate or from Persia. However much the hold of Saracens on the Holy Places might be resented by the West, the booty won from them by the crusaders or bought from them in trade was

> thought fit to adorn the most revered shrines in Western Christendom. Thus fine fabrics of Islamic origin sometimes even bearing invocations to Allah and the Prophet-were used to enwrap the bones-of Christian saints. Byzantine mosaics, silks, and ivories, Persian ceramics and textiles, Egyptian and Syrian glass and metal-work, as well as many of the products of Mesopotamia and Moorish Spain, were highly prized as being manifestly superior to anything that could be made in western Europe. It was largely by imitation and, in the end, sometimes by improvement of the techniques and models that had come from or through the Near East, that the products of the West ultimately rose to excellence….
>
> Technologically, the West had little to bring to the East. The technological movement was in the other direction. Not seldom, and specially under stress of persecution and war, there were emigrations of Eastern craftsmen to the West. These taught their methods to European pupils and apprentices, and so added the technical traditions of their own lands to those already being practised in Latin Christendom.'[2304]

To this, Lynn White's response was vitriolic. White used first *Speculum*,[2305] and, above all *Technology and Culture*,[2306] a quarterly he set up soon after Singer's book, and with him (White) taking one of the leading positions in the said journal to lead the attack on Singer et al. In a particular instance, Lynn White says:

> 'The five plum volumes of a history of technology edited under the direction of C. Singer give the layman a quite false impression of knowledge. These volumes are 'a codification of error.'[2307]

White, it must be said, is not alone in adopting an aggressive stand towards those deviating from the Eurocentric interpretation of history. This is common, a sort of Eurocentrist inquisition permeating all subjects. Any book or journal, including the famed *ISIS* (founded by George Sarton,) deviating from the usual Eurocentric perception of the history of science and technology suffers the same onslaught. Many instances confirm this. Menocal, for instance, suffered for daring to see the Islamic source of Spanish/Provencal poetry;[2308] Castro faced the ire of many when

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[2304] Ibid; pp. 754-6.
[2305] *Speculum*: vol 33, 1958, pp 130-5.
[2306] *Technology and culture*: Vol 1 (1958), at pp 340-1.
[2307] Lynn White Jr: The Act of Invention; in *Technology and Culture*; Vol 3; pp 486-500; at p. 486.
[2308] M.R. Menocal: *The Arabic Role in Medieval Literary History (a Forgotten Heritage)* (University of Pennsylvania Press; Philadelphia; 1987), p. xiii.

he raised Islamic influences on Spanish culture;[2309] G. Gheverdese Joseph complained of the harsh treatment he was subjected to for demonstrating the non Western origins of modern mathematics.[2310] The list goes on, and this author expects the same.

In view of Lynn White and his colleagues' ferocious guard of Western motherhood to all that is good and sublime, the best treatment of Islamic technology could only, come from outside the organised fraternity of modern Western academia, in the person of Donald Hill. Decades after Wiedemann, Hill, a well qualified engineer, working in the East, began rebuilding the place of Islamic technology, first with the translation into English of the works of the principal Muslim engineers, al-Jazari[2311] and the Banu Musa brothers.[2312] Then, in collaboration with Al-Hassan,[2313] and also single handed,[2314] Hill enlightened scholarship on the merits of Muslim engineering and technology, adding to the earlier, but limited, contributions by de Vaux,[2315] Mieli[2316] and Singer,[2317] and a few others.

Hence, with great reliance upon Hill, primarily, but also upon Pacey, Smith (Norman), Munro, and Winder, the following outline will consider diverse aspects of Islamic engineering and technology, including civil engineering, water and wind generated power, water raising machines, and fine technology, and in the course of that summing up, showing how the generally held notion that technology has little to do with the Islamic world is as fallacious as it is ridiculous. Before that, this outline will also

[2309] A. Castro: *Espana en su historia. Cristianos, moros y judios* (Buenos Aires: Losada, 1948), 709 pp;
Castro was savaged by Albornoz amongst others. See: S. C. Albornoz: *L'Espagne Musulmane*, French translation of earlier Spanish version (Paris, 1985).
[2310] See To the Editor: *ISIS*, Vol 85; pp. 668-70.
[2311] Al-Jazari: *The Book of Knowledge of Ingenious Mechanical Devices*, tr. D. Hill, (Dordrecht, Boston, 1974).
[2312] Banu Musa: *The Book of Ingenious Devices*, tr and annoted by D. R. Hill (Dordrecht: Reidel, 1979), Arabic text, ed. Ahmad Y. al-Hassan; Aleppo: Institute for the History of Arabic Science, (1981).
[2313] A.Y. Al-Hassan, and D. R. Hill: *Islamic Technology*, op cit.
[2314] D.R. Hill:
-*Islamic Science and Engineering* (Edinburgh University Press, 1993).
-Arabic Fine technology and its influence on European Mechanical Engineering, in *The Arab Influence in Medieval Europe*, edition D.A. Agius and R. Hitchcock (Ithaca Press, 1994), pp 25-43.
-Engineering, in *Encyclopaedia* (R. Rashed), pp 751-95.
[2315] C. de Vaux: *Les Penseurs;* op cit; chapter vi: La Mecanique, pp 168-94.
[2316] A. Mieli: *La Science Arabe;* op cit.
[2317] C. Singer: ed: *Studies in the History and Method of Science*, 2 vols; Oxford; and C.J. Singer et al: *History of Technology*; op cit; particularly pp 753-777.

raise the crucial issue relating to the foundation of Islamic engineering and technology. First, though, for the sake of convenience, a brief outline on the main Muslim engineers is necessary.

2. Muslim Engineers and Writers on Engineering:

There is a very early treatise, Munro points out, on the making of water clocks, attributed to Archimedes, but in reality a very early Muslim work, possibly written toward the end of the 8th century,[2318] this is a further issue open for query. Less doubtful, though, is the identity of the earliest Muslim engineers known to us: the three brothers: Muhammad, Ahmed and al-Hassan, known as the Banu Musa brothers. They flourished at the Abbasid court in the 9th century, and are the authors of about twenty works, only three of which have survived. There is a good entry on them in the Dictionary of Scientific Biography, even if the focus in it is on their mathematical works.[2319] Their most renowned engineering work is the *Kitab al-Hiyal* (Book of Ingenious Devices) translated into English by Hill.[2320] Written in Baghdad about 850, this manuscript can be found in the Vatican (No 317) and also in Berlin/Gotha (Ahlward No 5562/Pertsch No 1349).[2321] *Kitab al-Hiyal* includes the description of about a hundred devices, including trick vessels of various sorts, fountain lamps, and other apparatuses and gears including a gas mask for use in polluted wells. By far, one of the best works for any engineer to study such devices technically is a fairly recent publication by the IRCICA Centre at Istanbul, under the authorship of A. Bir.[2322] This publication brings into focus many details on how the devices by the Banu Musa worked, their use, and their reconstruction. The Banu Musa's work itself highlights a mastery of aerostatic and hydrostatic pressures, and the use of automatic control and switching systems, which, according to Hill, makes it a unique achievement, to be surpassed only in modern times[2323] Wiedemann has focused on an apparatus used to gather pearls, which is formed by two

[2318] J.H. Munro: Technology treatises in *Dictionary of the Middle Ages*; op cit; vol 11; pp 641-2. at p. 641.
[2319] D. Debagh: Banu Musa; in *Dictionary of Scientific Biography*; Vol 1; pp 443-6.
[2320] Banu Musa: *The Book of Ingenious Devices*, op cit.
[2321] A. Bir: *The Kitab al-Hiyal of Banu Musa Bin Shakir* (IRCICA, Istanbul; 1990).
[2322] Ibid.
[2323] D.R. Hill: Arabic Fine Technology, op cit, p. 27.

half cylinders lowered to the deep sea, and which close upon each other when pulled up.[2324] Klemm also gave his attention to this instrument.[2325] This particular instance amongst many others, so anodyne it would seem, had many implications, however. First it discredits the opinions of mainstream historians of technology who hold the view that Islamic technology consisted only in water clocks and other toys for the amusement of courtiers. It highlights, instead, the practicality of Islamic technology; i.e for economic purposes; and also highlights Islamic precursors to modern tools and gears.

In the 10th century, the construction of automata was probably a well established practice, since part of a scientific encyclopaedia is devoted to the subject.[2326] This is *The Keys to the Sciences* (Mafatih al-Ulum), compiled in about 980 by Abu Abd Allah al-Khwarizmi (not the mathematician who lived a century and half earlier). The eighth treatise deals with ingenious devices (hyals), and lists a number of components and techniques with etymological information that were used by makers of these machines.[2327] This is a particularly useful work since al-Khwarizmi does not limit himself to definitions but also includes descriptions of manufacturing processes.[2328]

From Spain came al-Muradi and al-Zarqali. The only known manuscript of al-Muradi (11th century) is so badly defaced that it is impossible to deduce from it precisely how any of the machines were constructed. Included in the treatise are five large automata machines that incorporated several significant features: each such device, for instance, was driven by a full size water wheel.[2329] The text mentions both segmental and epicycle gears, and although the illustrations are in other respects quite incomprehensible, they clearly show gear trains incorporating both types of gearing, a century earlier than Al-Jazari's (fl. 1206) water raising machines, which also incorporate segmental gears.[2330] Sophisticated gears for transmitting high torque first appeared in Europe in the astronomical

[2324] E. Wiedemann: *Beitrage*, op cit, p. 343.
[2325] A F. Klemm: *History of Western technology*; tr by D. Waley Singer (George Allen and Unwin Ltd, London, 1959), pp 74-6.
[2326] D.R. Hill: *A History of Engineering in Classical and Medieval Times* (Croom Helm; 1984), p. 203.
[2327] Ibid.
[2328] E. Wiedemann: *Aufsatze sur arabischen Wissenchaftsgeschichte*; 2 vols; Olms (Hildesheim; 1970), vol 1; pp. 71-4.
[2329] D.R. Hill: *A History of Engineering*; op cit; p. 203.
[2330] Ibid.

clock completed by the Italian Giovanni de'Dondi about 1365.[2331] By some coincidence, and from the picture of one of al-Muradi's design, it comes out that his (Al-Muradi's) manuscript was preserved in Florence at the Bibliotheca Laurenziana.[2332] This very probable passage of knowledge from al-Muradi to De'Dondi, again, opens the issue of impact and transmission of Islamic technical knowledge.

At the same time as al-Muradi flourished so did Al-Zarqali of Toledo. Born to a family of artisans, he entered the services of Qadi Ibn Sa'id of Toledo as a maker of delicate instruments. Around 1062, he constructed the water clocks of Toledo, which are described by al-Zuhri, and conveyed to us by Millas Vallicrosa.[2333] A brief outline here highlights the ingenuity of the device. The clocks consisted of two basins, which filled with water or emptied according to the increasing or waning of the moon. At the moment when the new moon appeared on the horizon, water would begin to flow into the basins by means of subterranean pipes, so that at day-break there would be the fourth of a seventh part, and at the end of the day half a seventh part, of the water required to fill the basins. In this proportion the water would continue to flow until seven days and as many nights of the month had elapsed, by which time both basins would be half filled. The same process during the following seven days and nights would make the two basins quite full, at the same time that the moon was at its full. However, on the fifteenth night of the month, when the moon began to wane, the basins would also begin to lose every day and night half a seventh part of their water, until by the twenty-first of the month they would be half empty, and when the moon reached her twenty-ninth night not a drop of water would remain in them. It is worthy of remark that, should anyone go to any of the basins when they were not filled, and pour water into them with a view to quicken its filling, the basins would immediately absorb the additional water and retain no more than the just quantity; and, on the contrary, were anyone to try, when they were nearly filled, to extract any or the whole of their water, the moment the hands are raised, the basins would pour out sufficient water to fill the vacuum in an instant. The clocks were in use until 1133, when Ibn Zabara was given permission by Alfonso VII to see how they worked, but failed to reassemble them after dismantling them. As Al-Zarqali was dead by then, the details of his techniques were lost.[2334]

[2331] D.R. Hill: Engineering; op cit, p. 789.
[2332] D.R. Hill: *Islamic Science*; op cit, p 142.
[2333] J.M. Millas-Vallicrosa: *Estudios Sobre Azarquiel* (Madrid-Grenada, 1943-1950), pp. 6-9.
[2334] C. Ronan: The Arabian Science, op cit; p. 215.

A maker of instruments who will be fully considered further on in the chapter on physics, is Al-Khazini. Al-Khazini (d. 1123) in the eighth treatise of his *Book of the Balance of Wisdom,* describes the construction of two steelyard clepsydras, a light one for 1 hour operation and a large one for 24 hour operation.[2335] What is worthy of attention about such works is al-Khazini's awareness of the physical properties of fluids.[2336] The clepsydras were designed to work either with water or sand. In the larger device a clepsydra is attached to the end of the short arm of the steelyard; a large weight and a small weight are suspended from the long, graduated arm.[2337] As the water or sand discharges, the weights are moved along the arm to bring the machine into balance. The hours are read from the position of the large weight, the minutes form the position of the small one.[2338]

A better known Muslim engineer is Al-Jazari who spent his working life at the service of the Turkish Ortoqid dynasty, which he served from about 1180 until some time between 1200 and 1220.[2339] Al-Jazari narrates his experience:

> 'I was in [Nasir ad-Din's] presence one day and had brought him something which he had ordered me to make. He looked at me and he looked at what I had made and thought about it, without my noticing. He guessed what I had been thinking about, and unveiled unerringly what I had concealed. He said, "You have made peerless devices, and through strength have brought them forth as works, so do not lose what you have wearied yourself with and have plainly constructed. I wish you to compose for me a book which assembles what you have created separately, and brings together a selection of individual items and pictures."[2340]

Thus he wrote *Al-Jami Bain Al-Ilm Wal-Amal Al-Nafi Fi Sinat'at Al-Hiyal* (A Compendium on the Theory and Practice of the Mechanical Arts), a treatise Sarton sees as 'the climax of this line of Muslim achievement.'[2341] However, it had to wait until Hill translated it in 1974, seven centuries and

[2335] Al-Khazini: *Kitab Mizan al-Hikma*, Hyderabad; partial English translation by N. Khanikoff (1859). *Journal of the American Oriental Society* vol 6: pp. 1-128;
[2336] D.R. Hill: *A History of Engineering*; op cit; p. 233.
[2337] Ibid.
[2338] Ibid.
[2339] In R.B. Winder: Al-Jazari; op cit; p. 188.
[2340] Ibid.
[2341] G. Sarton: *Introduction;* vol.2; page 510.

68 years after it was completed by its author, to become more accessible.[2342]

Winder notes that fifteen copies of the treatise are available, fourteen in Arabic, the earliest dating from 1206; and the latest, a Persian translation, dated from 1874.[2343]

Al-Jazari's treatise includes water and irrigation devices, machines where robot girls place a drinking glass in the ruler's hand, mechanical flutes, decorative items such as a monumental door with one of the earliest descriptions of green-sand casting... etc.[2344] Also included are monumental water clocks, with great spectacular visual effects: circles representing the zodiac rotating at constant speed; birds discharging pellets from their beaks to sound the hours; and doors opening at regular intervals to reveal musicians performing on their instruments.[2345] Devices, which seem simple and even trivial, but which involve mechanisms of real ingenuity, and that were to impact dramatically on subsequent technology.[2346]

Al-Jazari was clearly a master craftsman in his own right, who was capable of constructing large and small machines entirely with his hands.[2347] This consisted of metalwork of all kinds, including casting in copper, brass and bronze, soldering and tinning, sheet metalwork and so on.[2348] For his larger devices he would have needed the help of a labourer, and he may have trained apprentices, but otherwise he required no outside assistance.[2349] In comparison, the Latin treatise by Theophilus in the 1120s is the work of a master craftsman in paint, glassmaking and metalwork,[2350] but with an engineering content which is much less than that of al-Jazari.[2351]

Munro brings to attention the little known (or studied) Ridwan ibn Muhammad al-Sa'ati, who in 1203 wrote a lengthy treatise on the repair of a monumental water clock over the Jayrun Gate in Damascus. Ridwan's

[2342] D.R. Hill: *The Book of Knowledge of Ingenious Mechanical Devices*, Dordrecht, Boston, 1974.
[2343] R.B. Winder: Al-Jazari; op cit; p.188.
[2344] Ibid.
[2345] In J.H. Munro: Technology; op cit; p. 642.
[2346] D.R. Hill: Science; op cit; J.H. Munro: Technology; etc.
[2347] D.R. Hill: *A History of Engineering*; op cit; p.10.
[2348] Ibid.
[2349] Ibid.
[2350] Theophilus: *On Divers Arts;* Tr. From the Latin with introduction and notes by J.G. Hawthorne and C. Stanley Smith (Dover Publication Inc; New York; 1979).
[2351] D.R. Hill: *A History of Engineering*; op cit; p.10.

work is only available in one manuscript, dated from the 16th century. A complete edition of the work has not been published yet.[2352]

One of the very rare figures of Islamic science, who flourished after the 13th century, is the 16th century Syrian Taqi Eddin. In 1551, in Damascus, he completed *al-Turuq al-saniyya fi alat al-ruhaniyya* (The Sublime Methods of Spiritual Machines,). The manuscript is located in Dublin's Chester Beatty Library (No 5252), but was edited by A.Y. Al-Hassan in 1976.[2353] The manuscript is distinguished by its approach and style, both simple, intelligible and precise, and the many drawings, such as those of various methods of water elevation.[2354] There are descriptions and illustrations of clocks, weighing machines, pumps, water turbines, and various other machines.[2355] Al-Hassan stresses the significance of Taqi Eddin's treatise in completing a lost link in the history of Islamic technology, besides describing several new machines which are not found in either the Banu Musa or Al-Jazari's work.[2356]

3. Foundations of Islamic Technology and Engineering:

The demands of a vast civilisation, which extended from Spain to China, Anawati explains, made it necessity for Muslim rulers to use to the maximum the resources they had available in their territory. Science was thus required to make an important contribution, and 'technical arts' were developed in the construction of irrigation works, of canals, in ways of communication and in the erection of hydraulic machines.[2357] This is very obvious in the early history of Islam, and in the particular instance relating

[2352] J.H. Munro: Technology, op cit; at p. 641.
[2353] *Taqi al-Din and Arabic Mechanical Engineering, with the Sublime Method of Spiritual machines;* A. Y. Al-Hassan; in Arabic; Institute for the History of Arabic Science (University of Aleppo; Syria; 1977), pp. 165.
[2354] A.M. Hassani: Arab Scientists revisited: Ibn al-Shatir and Taqi Ed-Din; in *History of Science*; vol xvii (1979) pp. 135-40. at p. 139.
[2355] C.G. Ludlow and A.S. Bahrani: Mechanical Engineering during the early Islamic period; in *Chartered Mechanical Engineering*; Nov 1978; pp. 79-83; at p.79.
[2356] A.M. Hassani: Arab Scientists revisited; op cit; p. 139.
[2357] G. Anawati: Science, in *The Cambridge History of Islam,* ed P.M. Holt et al; vol 2 (Cambridge University Press, 1970), pp. 741-79, at p. 756.

to the foundation of new cities out of the sand, such as Al Qayrawan, Samarra, and Basra. The early historian, Al-Baladhuri (d. ca. 892) has left us an account of the foundation of the latter city, and the measures subsequently taken to supply it with water for irrigation and drinking.[2358] When Utba bin Ghazwan was the commander of a Muslim army in southern Iraq in 638, he selected the site of Basra after consultation with Caliph Omar as an encampment for his troops.[2359] It was located 15 km to the west of the Shatt al-Arab. In the early years it was simply an army camp consisting of huts made from reeds, and drinking water had to be transported from the Shatt al-Arab.[2360] Under Caliph Omar the enterprise of excavating canals to the site from the river was begun, and in the 660s, under the early Umayyads, were completed great canals, the Nahr Ma'qil, which came down from the north east and carried shipping from Baghdad; the other the Nahr al-Ubulla, which carried ships going south east to the Gulf. [2361] The canals were linked by another canal, upon which the city itself was located, and a great many irrigation canals were then excavated.[2362] The 10th century geographer al-Istakhri, describes its enormous network of canals and its abundant agricultural produce.[2363] Basra became a thriving centre for agriculture, and at this early point the most important city in Iraq for commerce, learning and finance.[2364]
This pattern is repeated everywhere Muslims advanced, and in and around all the new cities they founded: Kufa, Samarra, Baghdad, Al-Qayrawan, Fes, etc. Fes, for instance, a newly founded city of the early 9th century,[2365] did not just have a large number of springs, whose water was distributed for various requirements, and led to houses, places of worship, colleges, hostels, etc, but also a river, Wadi Fes, which supplied water for driving mills, clearing away refuse, and also for irrigation. Such functions were accomplished thanks to vast construction works.[2366] In al-Qayrawan, the

[2358] Al-Baladhuri: *Kitab Futuh al-Buldan;* Ed. M. J. de Goeje (Brill; Leiden; 1866); pp. 345-71.
[2359] Al-Baladhuri: Kitab; in D.R. Hill: *A History of Engineering;* op cit; p.25.
[2360] Ibid.
[2361] Ibid.
[2362] Ibid.
[2363] Al-Istakhri: *Kitab al-Masalik wa'l mamalik*; Ed. M.G. Al-Hini (Cairo; 1961), p. 57.
[2364] D.R. Hill: *A History of Engineering; op cit*; p.25.
[2365] E. Levi Provencal: La Fondation de Fes; in *Islam d'Occident* (Librairie Orientale et Americaine; Paris; 1948), pp. 1-32.
[2366] R. le Tourneau: *Fes avant le protectorat* (Casablanca; 1949), pp. 232-9. Editor: irrigation in North Africa, and Muslim Spain; *Encyclopaedia of Islam;* vol 5; op cit; p. 877.

Muslim engineers showed great skills in constructing reservoirs that brought together high aesthetics and engineering ingenuity.[2367]
These multiple instances serve to demonstrate how ridiculous is the assertion found amongst most Western historians that Muslims only kept engineering works from previous cultures, when such new cities and their engineering works did not exist before Islam.

Social demand had a further impact on technological advance. Hill explains that the standard of technology at any time depends mainly upon the demands of society, and that wherever there are large urban communities to be fed, clothed and provided with the raw and finished materials for commerce, there is to be found technology applied to agriculture, communications and industry.[2368] Muslim geographers in the 10th century described a society in which the range of foodstuffs, the quality of textiles, and the standards of living in general were far more advanced than those of Europe, and where utilitarian technology was also more advanced.[2369] Courtly circles, for instance, sought to be amused by trick devices, and this stimulated the rise of fine technology despite the apparent triviality of some devices.[2370] The links between practical necessity and the advance of Islamic technology and engineering are obvious from the fact that amongst the best sources for information on the subject are books written for the instruction of the muhtasib.[2371] He was the official appointed by the state to supervise markets, whose duties ranged from supervising the daily affairs of the market, the maintenance of moral standards and religious observance; quality and quantity control over retailers and manufacturers; sanitation and water supply; checking the manufacture of building materials and the construction of houses, etc.[2372] Usually an experienced craftsman was made responsible to the muhtasib for the maintenance of standards in his own trade, and so there is a great deal of useful information in the hisba manuals about manufacturing and construction methods.[2373]

[2367] A. Solignac: Recherches sur les installations hydrauliques de kairaouan et des Steppes Tunisiennes du VII au Xiem siecle, in *Annales de l'Institut des Etudes Orientales*, Algiers, X (1952); 5-273.
[2368] D.R. Hill: *A History of Engineering;* op cit; p.4.
[2369] Ibid.
[2370] Ibid.
[2371] Such as Ibn al-Ukhuwwa: *Ma'alim al-Qurba fi Ahkam al-Hisba*; ed by Reuben Levy; With Arabic text; notes and abridged English translation (Gibb Memorial Series); New Series (London; 1938).
[2372] D.R. Hill: *A History of Engineering*; op cit; p.9.
[2373] Ibid.

Hill also points out to the fundamental element already shown here repeatedly, how the demands of the faith stimulated sciences, in this instance through the requirement of astronomers for timepieces and for observational and computational instruments.[2374] Stock also notes how in Islam the dependence on well made apparatuses did not just mean that theory and practice were brought closer together, but also that scientists such as al-Battani were also expert makers of instruments that enhanced their powers of observation and calculation.[2375]

Very possibly due to these factors, the status of the artisan/craftsman in Islam was quite high, especially in comparison to the Christian West. Stock points out, that it may be, that Bernard of Tiron, a wandering preacher who died in 1117, founded a house specifically as a haven for craftsmen, but the real model for change came once again from Islam, in which the status of the artisan had changed from that of the slave to that of the free labourer.[2376] The artisan scientist, who was considered an aberration in the ancient world, was more a norm in Islam, artisans playing a leading part in the transfer of techniques throughout the highly mobile Muslim world.[2377] The importance Muslims granted their craftsmen or instrument makers is also noted by Sarton 'in the extravagant praise' lavished on the instrument maker: Badi al-Astrulabi.[2378] Both this attitude to the artisan and his status were eventually transferred to Christendom.[2379]

Islamic waqfs (religious endowments) also stimulated and made possible the construction, maintenance, and management of large engineering structures and works. The waqfs were central in the management of canalisation networks.[2380] In Tunis, for instance, water supply was undertaken by both central administration and such religious endowments.[2381] The jurists also permit the constitution of water rights and water sources, where they are on private property, into waqf.[2382] Many qanats and canals and rights to a share of the use of various sources of

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[2374] Ibid; p.4.
[2375] B. Stock: Science, Technology, and Economic Progress in the Early Middle Ages: in *Science in the Middle Ages*; ed by D.C. Lindberg (The University of Chicago Press, Chicago, 1978); pp. 1-51; p. 21.
[2376] Ibid; p. 31.
[2377] Ibid; pp. 21 and 31.
[2378] G. Sarton: *Introduction,* op cit, vol 2; p.13.
[2379] B. Stock: Science, op cit, p. 21.
[2380] S. Denoix: Bilans in *Grandes Villes*; op cit; p. 294.
[2381] Ibid.
[2382] A.K.S. Lambton: Ma', in *Encyclopaedia of Islam*; op cit; vol 5; p. 871.

water have been so constituted, and the Yazd region, in Persia, is particularly illustrative of this practice.[2383] Many rich families also contributed much of their wealth to the maintenance and construction of water works.[2384] The provision of drinking water was considered a meritorious action, and many individuals built qanats and constituted them into waqfs.[2385] The 10th century geographer, Al-Istakhri, for instance, notes how in Samarkand, the provision of water was done in God's name.[2386] The city was, thus, richly supplied with fountains and baths by a lead lined channel carried on a bridge.[2387]

The early Islamic state provided a legal corpus and an administrative framework in the implementation and management of civil engineering works. The legal corpus, for instance, stated amongst other things that canals are the property of the landowner or landowners in whose property they are located; where they are the common property of several landowners, none of them may make unilateral changes in arrangements such as sharing the water, building a mill or bridge over it, etc.[2388] The responsibility for the upkeep of great rivers in some parts was vested in the imam, and cleaning or dredging and repair of their banks was carried out by the imam and paid for by the public treasury.[2389] Other arrangements were prevalent; in Fes, an *Amin al-ma* (Water Supervisor/Manager) was charged with supervising the workmen maintaining canalisations, and regulations were in place for the removal of sediments obstructing canalisations.[2390] In Egypt, good maintenance of the dams and reservoirs was deemed central to the life the country, and writings by Egyptian scholars such as Al-Nuwayri[2391] and Al-Makrizi highlight this.[2392] The state had overall responsibility over matters pertaining to bridges, roads, dams, and canals.[2393] Under the Mamluks, there was an officer for the inspection of dams in each province: the

[2383] Ibid.
[2384] S. Denoix: Bilans; op cit; p. 294.
[2385] A.K.S. Lambton: Ma', in *Encyclopaedia of Islam*; op cit; vol 5; p. 876.
[2386] Al-Istakhri: *Kitab Masalik wal-Mamlik*; ed. De Goeje (Leyden; 1927), p. 140.
[2387] Ibid; p. 177.
[2388] M.J.L. Young: Water in Classical Islam; under Ma'; *Encyclopaedia of Islam*; op cit; vol 5; New Series; p. 860.
[2389] A.K.S. Lambton: Ma', in *Encyclopaedia of Islam*; op cit; vol 5; p. 873.
[2390] S. Denoix: Bilans; op cit; p. 294.
[2391] Al- Nuwayri: *Nihayat al-Arab* (Cairo, 1923), vol I, p 265.
[2392] Al-Makrizi: *Khitat*, Cairo, 1853-4 ed; vol I, p.61.
[2393] D. Behrens Abouseif et al: Cairo: in *Grandes Villes Mediterraneenes; op cit;* pp. 177-203; p. 189.

Kashif al-Djusur.[2394] Under both Ayyubids and Mamluks, sultans and large land-holders dug and maintained canals and dams, whilst distinguished emirs and officials were made chief supervisors of such works.[2395] The Sultans also regularly imposed levies on the population whenever they implemented large projects, and in emergencies (earthquakes, flooding…).[2396] In Iraq, large project ventures were in the realm of the state, whilst the local population focussed on lesser duties.[2397] The state, for instance, dredged canals, and the population maintained the banks.[2398] In Nishapur, further to the east, the irrigation system was supervised by a force of inspectors and guards, who were responsible for the maintenance of the qanats.[2399]

4. Civil Engineering:

One of the recurrent problems encountered in the reading of the history of science goes beyond the neglect of Islamic contribution, and that is the systematic taking away of such accomplishments from the Muslims as is the case here. Smith notes, indeed, how irrigation technologies found in Spain were acknowledged to be of Islamic origins until 1864, when the French historian, Aymard, in his *Irrigations du Midi et de l'Espagne,* denied any such Islamic role, and was followed by others, who built on his legacy to attribute such skills to post Muslim Spain.[2400] This has become a generalised practice amongst Western historians in their treatment of almost every single Islamic accomplishment. Halpern has noted how many of the once great achievements of Muslim civilisation are taken away from the Muslims one after the other.[2401] The dominant practice has been for historians to complement each other in the

[2394] H. Rabie: Pre-20th century irrigation in Egypt, in *Encyclopaedia of Islam*, Vol V, pp 862-4; p. 863.
[2395] Ibid; p 862.
[2396] D. Behrens Abousseif et al: Cairo; op cit; p. 189.
[2397] C. Cahen: Irrigation in Iraq; *Encyclopaedia of Islam*, second edition, Vol V, Leiden, Brill, pp.864-5.
[2398] G. Wiet et al: *History*; op cit. p. 312.
[2399] Al-Istakhri: *Kitab al-massalik*; op cit; p. 145.
[2400] N. Smith: *Man and Water; A History of Hydro Technology* (Peter Davies; London; 1975), p. 19.
[2401] L. Halpern: *l'Essor de l'Europe (XI-XIII Siecles)* (Presses Universitaires de France; Paris; 1941); p. 101.

suppression of the Islamic legacy established by earlier authorities, and this has affected literally every aspect of the sciences and civilisation. Hence, in relation to chemistry, the 18th century historian Gibbon declared that the science of chemistry owes its origin and importance to the industry of 'the Saracens', 'They first invented and named the alembic for the purpose of distillation, analysed the substances of the three kingdoms of nature, tried the distinction and affinities of alcalis and acids, and converted the poisonous minerals into soft and salutary medicines.'[2402] Yet a century after Gibbon the originality of the Muslims in all these respects had been considerably diminished. Berthelot (and his countless followers) denied them any significant contribution in this field, ascribing rather to Western alchemists whatever advances were made in the Middle Ages.[2403] Equally, the Gothic style was amply demonstrated by Christopher Wren in the 17th century to be of 'Saracen' authorship, at a time, when Gothic was identified with the barbaric,[2404] and yet, today, hardly any modern historian sees anything Islamic in such style. The same with regard to the Arabic numerals, once shunned,[2405] regarded even as a symbol of 'Saracen magic,'[2406] then, as they became the foundation of modern civilisation, and though a gradual re-working by modern historians, these numerals are no longer called Arabic, and hardly any modern historian fails to call them Hindu, or even attribute their origins to Western sources.[2407] Experimentation, and the experimental method were viewed in the Western Middle Ages as dabbling with the occult, any person who performed experiments or made astronomical observations soon incurring the suspicion that he carried on forbidden intercourse with the world of demons.[2408] Gradually, again, in modern historian interpretations, experimentation becomes a purely Western creation, regardless of the evidence.[2409] And the list can go on endlessly, how each modern historian, building on his predecessor, removes more traces of the Islamic role, until any Islamic role is fundamentally erased from nearly all disciplines and aspects of civilisation.

[2402] In C.H. Haskins: *The Renaissance of the Twelfth Century;* op cit. pp. 319-20.
[2403] Ibid. p. 320.
[2404] J. Sweetman: *The Oriental Obsession* (Cambridge University Press, 1987), p.6.
[2405] D.J. Struik: The Prohibition of the use of Arabic numerals in Florence: *Archives Internationales d'Histoire des Sciences* Vol 21 pp 291-4; p. 294:
[2406] William of Malmesbury: History of the kings of England, in L. Cochrane: *Adelard of Bath* (British Museum Press, 1994), p. 43.
[2407] See H.P. Lattin: The Origin of our present system of notation according to the theories of Nicholas Bubnov. In *ISIS*; XIX; pp. 181-94; at p. 182.
[2408] E.J. Dijksterhuis: *The Mechanization of the World Picture* (Oxford at the Clarendon Press; 1961), p.104.
[2409] A.C Crombie: *Robert Grossesteste;* op cit

In respect to hydraulic technologies developed in Spain, taking their authorship away from the Muslims runs against historical reality. If the Muslims were not the authors of Spanish dams as most Western historians assert, the question to ask then is:
'Where did the conquering Christians learn such skills more advanced than found anywhere else in Europe'?
Had such re-conquering Christians come from parts or regions where there existed a great expertise and established tradition in such technologies, one would accept it. But this is not the case at all. Historical evidence shows that the most advanced medieval dams in any part of the West were in Spain.[2410]
Secondly, it makes no sense that Westerners formerly plunged in utmost darkness suddenly, out of nowhere, in the 12th-13th centuries discovered all these skills, it seems by a miracle.
Thirdly, and more importantly, as will be demonstrated in the following, hydraulic technologies, like other civil engineering skills, were a widespread art throughout the vast land of Islam, from east to west. The Muslims devised many skills, techniques, constructions and structures at least six centuries prior to anything of similar advancement and sophistication in Western Christendom.

Dams:

Dams, according to Smith, 'not only represent some of the most impressive achievements of engineers over the centuries, but their vital role in supplying water to towns and cities, irrigating dry lands, providing a source of power and controlling floods is more than sufficient to rank dam building amongst the most essential aspects of man's attempt to harness, control and improve his environment.'[2411]
In Muslim Spain and Sicily, dams served irrigation, thus increasing yields, and making irrigation cheaper.[2412] At Dizful (Iraq), dams operated a great noria, which supplied with water all the houses of the town.[2413] One of the dams built in the year 960 over the river Kur, between Shiraz and Istakhr,

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[2410] See:
N.J. Schnitter: *A History of Dams* (A.A. Balkema, Rotterdam, 1994).
N. Smith: *A History of Dams;* op cit.
[2411] N. Smith: *A History;* op cit, preface, p.i.
[2412] A.M. Watson: *Agricultural; op cit* p. 104.
[2413] Le Strange: *The Lands of the Eastern Caliphate* (London, 1905), p. 239.

supplied 300 villages with water,[2414] and powered mills in Khuzistan. At the Pul-I-Bulaiti dam on the Ab-i-Gargar, the mills were installed in tunnels cut through the rock at each side of the channel, constituting one of the earliest examples of hydro-power dams.[2415] In Muslim Spain, from the Ebro right round the Guadalquivir, Muslim engineers built river dams, usually to feed irrigation canals but also to meet the needs of power and water supply as well.[2416]

Contrary to historians' assertions, Hill points out, there was no decline in engineering activities, including dam construction, in Muslim times.[2417] On the contrary, Hill insists, the new irrigation systems and the extension of existing ones (as described under agriculture) necessitated the construction of a large number of dams, many of which were small diversion dams, but several were large.[2418] Whether in the eastern or western parts of the realm, Muslim engineers were responsible for accomplishments in the field that surpassed anything seen before. The majority of the earliest Islamic dams were completed in Arabia itself; and full information on their height, length, and ratios between height and length is given by Schnitter.[2419] In Iraq, in the vicinity of Baghdad, a considerable number of dams were built during the Abbasid Caliphate.[2420] Such large dams include three across the Tigris.[2421] Consequently, a huge area around Baghdad was successfully irrigated by five cross country canals running from the Euphrates to the Tigris, water ways large enough not only to be navigable, but also requiring in one case large masonry arch bridges to give access from one tank to the other.[2422] At their heads, these canals were fed by dams or side regulators, and were, apparently, quite large structures.[2423] The main artery for the irrigation of the lands to the east of the Tigris was the Great Nahrawan Canal, which left the Tigris a short distance below Tikrit and rejoined the river about a hundred miles below Baghdad.[2424] Between the river and the mountains called Jebel Hamrin, the Muslim engineers enlarged the Nahrawan canal, lengthened it, and equipped it with a second inlet fed from a dam across the Tigris

[2414] A.M. Watson: *Agricultural*; op cit; p. 160.
[2415] N. Smith: *A History*, op cit, p. 81.
[2416] N. Smith: *Man and Water*; op cit; p. 21.
[2417] D.R. Hill: *A History of Engineering*; op cit; p. 57.
[2418] Ibid.
[2419] N.J. Schnitter: *A History of Dams*; op cit.
[2420] N. Smith: *A History of Dams*, op cit, p.78.
[2421] D.R. Hill: *A History of Engineering*; op cit; p. 57.
[2422] N. Smith: *Man and Water;* op cit; p. 16.
[2423] Ibid.
[2424] D.R. Hill: *A History of Engineering*; op cit; p. 24.

near Samarra (further to the North).[2425] The rivers Adheim and Dyala were dammed to provide water for a huge irrigated area, and in part supplied the city itself.[2426] Such works, Smith notes, were a manifestation of civil engineering in the grand manner.[2427]
Further east, in today's Afghanistan, three dams were completed by King Mahmoud of Ghaznah (998-1030) near his capital city, one of which named after him, was located 100 km SW of Kabul, and was remarkable for its dimensions, 32m high, and 220m long.[2428]
In Muslim Spain, Smith notes, a conscious attempt was made to recreate in Valencia or Cordova or Murcia the luxuriance of the Damascene Ghuta requiring the establishment of the same technical apparatus.[2429] Dams had to be built across rivers, primary and secondary canal systems were laid down with access to a suitable low level drain, usually the parent or some other river, and a system of sluices, regulators and flow dividers had to be constructed.[2430] The size of the huerta, the regime of the river and the local topography, were all factors in determining whether to use one structure or a series.[2431] It is in Cordoba, on the river Guadalquivir, where what is probably the oldest surviving Islamic dam in Spain can be found.[2432] According to al-Idrisi, it was built of Qibtiyya stone and incorporated marble pillars.[2433] The dam follows a zig-zag course across the river, a shape which indicates that the builders were aiming at a long crest in order to increase its overflow capacity. Remains of the dam can still be seen today, a few feet above the river bed, although in its prime, it was probably about seven or eight feet above high- water level and eight feet thick.[2434] On the Rio Segura, a very large area around Murcia was watered from just one dam located upstream from the city, but lower down the same river, where it flows across the flat plain between Orihuela and Guardamar, irrigation on a comparable scale was sustained by a network of low diversion dams.[2435]

[2425] N. Smith: *Man and Water*; op cit; p. 16.
[2426] Ibn Sarabiyun (Ibn Serapion): *Kitab Ajaib al-Aqalim al-Sab'a;* ed H. Von M'zik (Vienna; 1929), pp. 114-38.
[2427] N. Smith: *Man and Water*; op cit; p. 17.
[2428] N. Schnitter: *A History,* op cit, pp 88-9.
[2429] N. Smith: *Man and Water*; op cit; p. 21.
[2430] Ibid.
[2431] Ibid.
[2432] N. Smith: *A History*; op cit; p. 108.
[2433] In D.R. Hill: *Islamic Science,* op cit, p.161.
[2434] Ibid.
[2435] N. Smith: *Man and Water;* op cit; p. 21.

Smith focuses on the Muslim use of sophisticated land surveying methods to locate their dams in the most suitable sites, and also to lay out very complex canal systems feeding into, and out of them.[2436] Hill, for his part, extols most particularly Islamic techniques in desilting sluices, gauging rivers, design and location, all aiming for the structure to last as can be seen in Valencia, Cordoba and Murcia today.[2437] The Muslim ability to gauge a river and then design the dams and canals to match, as seen on the river Turia in Spain, correspond with modern measurements showing that the eight canals dug by the Muslims have between them a total capacity slightly less than that of the river.[2438] Astrolabes and trigonometric calculations also aided in the feasibility of such projects. The use of the astrolabe, for instance, made it possible to find the breadth of a river. The instructions were:

> 'Stand at the bank of the river and hold the astrolabe in your right hand and look through the hole of the eye piece with one of your eyes, raise the level of the Alidade and look towards the opposite bank. Keeping the alidade in the same position, look towards the ground. Note the point thus obtained. The difference between these points will give the width of the river.'[2439]

The dams erected by the Muslims prove the innovative, pioneering Islamic engineering ingenuity in the field. Many structures all over the Islamic world are witness to this. In the East, Schnitter notes that, with the exception of the Qusaybah dam near Madinah, a 30 m high-205 m long structure, which was slightly curved in plan, the alignment of all others was straight.[2440] About half such dams were provided with a flood overflow at one end, and often with a downstream training wall to guide the spilled water to a safe distance from the dam's foot. Schnitter also observes that about a third of such very early dams (7th-8th century) were still intact.[2441] In some cases dams were built with carefully cut stone blocks, joined together by iron dowels; the holes in which the dowels fitted were filled by pouring in molten lead.[2442] The result was an impressive structure of masonry such as the dam at Marib in Yemen with

[2436] N. Smith: *A History,* op cit, p. 88.
[2437] D.R. Hill: *Islamic Science*; op cit; p. 161.
[2438] Ibid.
[2439] Anonymous: *Risala fi Alat al-rasad*; Ms. 68. Rampur. In S.M. Alavi: *Arab Geography;* op cit; p. 115.
[2440] N. J. Schnitter: *A History of Dams*; op cit; pp-81-2.
[2441] Ibid; p. 82.
[2442] A. Pacey: *Technology;* op cit; pp.9-10.

its carefully cut and fitted blocks using lead dowels in their joints.[2443] It was also fourteen metres high and 600 metres long, with elaborate waterworks including sluices, spillways, a settling tank and distribution tank. It was so good a structure, it survived for about ten centuries until lack of financial and technical means made it impossible to maintain.[2444] One dam, in the neighbourhood of Baghdad, on the Uzaym river, was 575 feet long, with a trapezoidal cross section, 10 feet thick at the crest and 50 feet thick at the base, its maximum height being over 50 feet. It was built of cut masonry blocks throughout, connected with lead dowels poured into grooves, which is a fairly common Muslim technique.[2445] In Iran can be found the Kebar dam, dating from the 13th century, the oldest arched dam known to have survived.[2446] The dam has a core of rubble masonry set in mortar, the mortar made from lime crushed with the ash of a local desert plant, the addition of ash making the lime hydraulic. This resulted in a strong, hard and impervious mortar, ideal for dams, the very reason for the dam's long life, and the absence of cracks in it.[2447]

In Spain, the first arched dam in Spain was the Almansa dam, which marked the beginning of a long tradition of the sort in that country.[2448] According to Scott, the masonry of the reservoirs was of the finest description, and the cement used was harder than stone itself.[2449] Contingencies were also provided so that no overflow occurred, and no damage resulted even during the worst flooding. Evidence of Muslim engineering 'genius' is proved by the fact that these dams needed hardly any repair in a thousand years.[2450] The eight dams on the Turia River, at first sight seem to have an exaggerated amount of weight placed on their foundations, the masonry of each dam going some fifteen feet deep into the river bed, and further support provided by the addition of rows of wooden piles.[2451] Such solid foundations were justified by the river's erratic behaviour, which in times of flooding reaches a flow that is a hundred times greater than normal, the structure having to resist the battering of water, stones, rocks and trees.[2452] On the River Segura, the Muslims built a dam in order to irrigate vast lands in the Murcia region. But because of the nature of the terrain, location, design and construction

[2443] D. Hill: *Islamic Science*, op cit, at p. 159.
[2444] Ibid.
[2445] D.R. Hill: *A History of Engineering*; op cit; p. 57.
[2446] D.R. Hill: *Islamic Science*, op cit; p. 168.
[2447] N. Smith: *A History*; op cit; D.R. Hill: *Islamic Science*, op cit.
[2448] N. Smith: *A History;* op cit; p. 108.
[2449] S.P. Scott, *History;* op cit; vol 2; at pp. 601-2.
[2450] Ibid; p. 602.
[2451] N. Smith: *A History*, op cit, p. 93.
[2452] Ibid.

had to be perfected. Thus, the height of the dam was only 25 feet, yet its base thickness was 150 and 125 feet. This may seem excessive,[2453] but such thickness was necessary to meet the softness and weakness of the river's bed to prevent it from sliding along. The water flowing over the crest initially fell vertically through a height of 13-17 feet on to a level platform, running the length of the dam. This served to dissipate the energy of the water spilling over the crest.[2454] The over-flow then ran to the foot of the dam over flat or gently sloping sections of the face. In this way the whole dam acted as a spillway and the energy gained by the water in falling 25 feet was dissipated en route; thus the risk of undermining the downstream foundations was greatly reduced. As with other dams, rubble masonry and mortar were used for the interior, and the whole was finished with large masonry blocks.[2455]

In the Maghrib the most original reservoirs of all are found at Al-Qayrawan in Tunisia. These reservoirs, due to their sophistication, were, despite all evidence,[2456] attributed to both Phoenicians[2457] and Romans.[2458] Watson notes, how Gauckler, following the previous practice of European historians writing on the region, assigned virtually all the ruined irrigation works of Tunisia to the Romans.[2459] Such erroneous views were adopted by a number of learned historians until more recent archaeological excavations and studies proved their 9th century Islamic origin. Solignac's article on the subject also works towards the same corrective aim.[2460] Indeed, the construction of such dams goes back to the year 862, during the Aghlabid rule of the country.[2461] We have here, in one part, water

[2453] N. Smith: *A History*; op cit, pp. 94-7; D. Hill: *Islamic Science*, op cit, pp. 166-7.
[2454] Ibid.
[2455] Ibid.
[2456] M.Shaw: *Voyages de Shaw MD dans plusieurs provinces de la Barbarie et du Levant;* 2 Vols (La Haye, 1743), Vol II; pp 257-9; and E. Pelissier: *Description de la Regence de Tunis; Exploration scientifique de l'Algerie pendant les annees 1840-41-42* (Paris, 1853), pp 279-280.
[2457] A. Daux: *Recherches sur l'originalite et l'emplacement des emporia Pheniciennes dans le Zeugis et le Byzacium* (Paris, 1849).
[2458] H. Saladdin: *Enquetes sur les installations hydrauliques romaines en Tunisie,* published by Direction des Antiquites et Beaux Arts, et La regence de Tunisie (Tunis, 1890 a 1912).
R. Thouvenot: Les traveaux hydrauliques des Romains en Afrique du Nord in: *Realites marocaines, Hydraulique, Electricite* (Casablanca, 1951).
[2459] P. Gauckler: *Enquete sur les Installations hydrauliques Romaines en Tunisie*; 2 Vols (Paris; 1901-2).
[2460] A. Solignac: Recherches sur les installations hydrauliques de kairaouan et des Steppes Tunisiennes du VII au Xiem siecle, in Annales de l'Institut des Etudes Orientales, Algiers, X (1952); 5-273.
[2461] Ibid.

channels open to the sky, and in another, reservoirs meant for storing up streams of running water and, in some cases, water from certain springs and certain underground water levels.[2462] These reservoirs have two basins, one for decantation, one as a reserve, and sometimes, a third for drawing water from it.[2463] The two impressive linked cisterns were constructed for receiving the waters of the Wadi Merj al-Lil when it was in flood. These cisterns, which still stand, although appearing to be circular, both are actually polygonal, the larger having a diameter of just under 130 metres, the smaller one a diameter of 37.4 metres.[2464] The smaller receives the waters of the wadi and acts as settling tank; a circular duct, several metres above its base connects it to the larger cistern, which has a depth of about eight metres.[2465] On leaving the larger cistern, the water is decanted a second time into two oblong covered cisterns.[2466] Other than their impressive numbers, such reservoirs also offer a great attraction in their form and structure.

Bridges:

Diversity in landscapes and local conditions imposed a wide variety of designs and techniques in bridge construction; each bridge being constructed according to its own topographic setting.

Pontoon bridges were common, quick to assemble and highly practical.[2467] Many Muslim towns such as Baghdad, Seville, Fustat, etc, spread along both sides of a river, and had to be connected by such bridges. They were common in Iraq for crossing the two rivers and the major canals. In the 10th century, for instance, there were two such bridges over the Tigris at Baghdad.[2468] In Cairo, a pontoon bridge crossed from the city to the Island, and a second from there to the far bank of the river.[2469] About two centuries later, al-Idrisi describes the same arrangements, adding that

[2462] Ibid.
[2463] Ibid.
[2464] In D.R. Hill: *A History of Engineering*; op cit; p. 45.
[2465] Ibid.
[2466] K.A. C. Cresswell: *A Short Account Early Islamic Architecture* (Penguin Books; London; 1958), pp. 291-2.
[2467] Accounts on pontoon bridges in D. R. Hill: *Islamic Science*, op cit; at pp 154-5; and 'Engineering' in *Encyclopaedia* (Rashed ed) op cit; at p 763.
[2468] Ibn Hawqal: *Kitab Surat al-Ard*; op cit; p. 241.
[2469] Al-Istakhri: *Kitab al-masalik;* op cit; p. 39.

there were 30 boats in the first bridge and 60 in the second.[2470] The pontoons were tied at both ends by iron chains, and attached at each bank to firmly implanted posts. The traveller Ibn Jubayr, writing at the end of the 12th century, describes a bridge of large boats over the Euphrates at Hilla (which had chains on either side 'like twisted rods,' which were secured to wooden anchorages on the banks), and a larger one over a canal near Baghdad.[2471] Ibn Jubayr also mentions a similar, but larger bridge over a canal near Baghdad.[2472] There were also pontoon bridges on the rivers of Khuzistan,[2473] and on the Helmand river in Sijistan.[2474] Almost everywhere these bridges were supplemented by ferry services used to carry men, animals and goods.[2475] To avoid permanently blocking the waterway, the bridges across the canals were constructed of movable planks, which were taken up at certain times of the day.[2476] Erection of pontoon bridges on flowing currents, and anchoring boats at the right distances to receive the beams and decking of the roadway were challenging, though.[2477] Under such conditions, very heavy cables were used, and high maintenance was required.

Bridges of boats were not common in medieval Europe, but some were built, the first Rialto bridge in Venice, for instance, was a pontoon bridge built in the 13th century.[2478]

Stone bridges were also constructed in large numbers, and were innovative in their architecture. In Susiana, for instance, a pre-Islamic Sasanid bridge arch was daring in the length of its span, and baskets and pulleys had to be used to get down into the foundations, whilst the stonework was bound together with iron and lead.[2479] Many arch bridges were subsequently built in Muslim times, not only on rivers but also over irrigation canals.[2480] They served not just in carrying transport over water, but also in clearing the way for boats wherever waters were navigable. These bridges were

[2470] Al-Idrisi: *Description de l'Afrique et de l'Espagne;* Arabic text with Fr trans by R. Dozy and M.J. de Goeje (Brill; Leiden; 1866), p. 142 Arabic. P. 171 Fr.
[2471] Ibn Jubayr: *Rihla*; Arabic text ed by W. Wright (Leiden; 1852); amended version of Wright's text, M.J. de Goeje (Leiden; 1907), p. 213.
[2472] Ibid; p. 217.
[2473] Al-Istakhri: *Kitab al-Masalik*; op cit; p. 62.
[2474] Ibid; p. 141.
[2475] G. Wiet et al: *History*; op cit; p. 323.
[2476] Ibid.
[2477] D. Hill: *Islamic Science*; op cit.
[2478] W. B. Parsons: *Engineers and Engineering in the Renaissance*; 2nd ed (MIT Press; Cambridge, Mass; 1968), p. 89.
[2479] G. Wiet et al: *History*; op cit; p. 323.
[2480] D.R. Hill: *A History of Engineering*; op cit; p. 71.

constructed early in Islam, the 10th century geographer al-Istakhri describes one such bridge built under Umayyad rule in the late 7th century under the governor al-Hajjaj (661-714).[2481] It was a single arch of about 80 paces span, and so high that a man on a camel with a long standard in his raised hand could pass beneath it.[2482] Ibn Jubayr cites another such a bridge constructed by Ibn Tulun (9th century ruler of Egypt), which had forty arches, and was intended for military purposes, forming the first part of a causeway six miles long leading from the west bank of the Nile, from near the old quarter of Fustat in the direction of Alexandria.[2483] It was used as a passage for troops over the Nile floods, if an enemy approached from the East.[2484] Ibn Jubayr also mentions the many arch bridges over canals near Hilla in Iraq.[2485] Al-Qazwini (d. 1283) has left us a good description of the rebuilding of a great arch bridge at the town of Idhaj in Khuzistan in the 10th century.[2486] The bridge was 150 cubits in height and consisted of a single arch, supported on tapering masonry piers strengthened with lead dowels and iron clamps. The slag from iron workings was used to fill the space between the arch and the roadway.[2487] Under the Ottomans, a bridge built in the province of Thrace had 174 arches, and was 1,266 metres long.[2488] Islamic excellence in the construction of arch bridges is illustrated by the survival of many of them until the present day.[2489]

Suspension bridges were used to cross ravines in hilly countries. In the 10th century, Ibn Hawqal describes how the river Tab in Iran was crossed by a wooden bridge 'suspended between the sky and the water, its height above the water about 10 cubits.'[2490] The design of early Islamic suspension bridges, and large modern steel bridges, such as the Forth railway bridge in Scotland, Hill notes, are built on exactly the same principles.[2491]

The Islamic dominance in the field is noted by Hill, who observes that in non-Islamic Europe no bridges of note were built between the end of the

[2481] Al-Istakhri: *Kitab al-Masalik*; op cit; p. 91.
[2482] Ibid.
[2483] Ibn Jubayr: *Rihla;* op cit; pp. 214-5.
[2484] Ibid.
[2485] Ibn Jubayr: *Rihla;* op cit; in D. R. Hill: *History of Engineering*; op cit; note 27; p. 74.
[2486] Al-Qazwini: *Athar al-Bilad was Akhbar al-Ibad* (Beirut; 1960), p. 303.
[2487] Ibid.
[2488] D.R. Hill: *Islamic Science;* op cit; pp. 155-6.
[2489] Ibid.
[2490] D. Hill: Engineering, op cit, p. 762.
[2491] Ibid.

Roman Empire and the 12th century.[2492] After a time, however, the building of masonry bridges began in earnest. One of the earliest of these was the famous bridge at Avignon (southern France), begun in 1177, parts of which stand today.[2493]

Canals, Qanats, and Surveying:

Canals served for irrigation, transport and urban supply of water throughout the Islamic world. In the south of Iraq, due to the influence of the tides on the Shatt al-Arab and the lower reaches of the Tigris and Euphrates, there is a particularly favourable situation for irrigation.[2494] Thanks to a system of canals specially adapted to the situation, there is no need to use machines to raise the water to the fields, since it is always sufficiently raised by the tides to irrigate the fields.[2495] The cleansing of the canals is done automatically by the movement of the tides, and drainage is effected during the ebb tide. There is, therefore, no danger of salinisation, despite the presence of dissolved salts in the water due to the proximity of the sea.[2496] The Basra area, in the summer months, presents an area of vast plantations of date palms, providing shade for flourishing vegetable gardens.[2497] Under Caliph Omar (caliph 634-644), early canal construction took place there, and in the 660s, it was supplied with great canals, one of which came down from the north east and carried shipping from Baghdad, whilst the other carried ships to the Gulf.[2498]
Further north, Damascus had an extensive and complete water system, the rivers Barada, Qanawat, and Banyas supplying the city through two sets of underground canals, one for fresh water and the other for drainage, which brought water to mosques, schools, baths, public fountains, and private homes.[2499] Makkah also possessed three reservoirs, which were filled from the canals,[2500] whilst in the Muslim West, in Marrakech, water was brought to the city for drinking and irrigation by mainly subterranean

[2492] D.R. Hill: A History of Engineering; op cit; p. 71.
[2493] Ibid.
[2494] Ibid; p. 24.
[2495] Ibid; p. 25.
[2496] Raf van Laere: Techniques Hydrauliques en Mesopotamie Ancienne; *Orientalia Lovaniensa Periodica* (University of Leuven Press; 11; 1980), pp. 11-53; p. 22.
[2497] D.R. Hill: *A History of Engineering*; op cit; p. 24.
[2498] Ibid.
[2499] I.M. Lapidus: *Muslim Cities in the Later Middle Ages;* op cit; p. 70.
[2500] Al-Muqaddasi: *Ahsan al-Taqasim;* (De Goeje ed) op cit; p. 74.

canals from the mountains twenty miles to the south.[2501] Casablanca, too, had long had a network of water channels, some above the ground, and some below, which take the water as far as individual houses, as well as drains crossing the various quarters.[2502]

The qanat system, as seen above (under agriculture), was also widely diffused by the Muslims for both irrigation and urban water supply.[2503] The word 'qanat' in Arabic, Pacey explains, is said to be the same of the English word 'canal' which was initially used to mean a pipe, or tunnel carrying liquid.[2504] It consists, primarily, in tapping deep ground water without the use of lifting devices, but by sinking a series of wells and linking them underground.[2505] The vertical shafts constructed along the line of the qanat allow access for maintenance and removal of spoil.[2506]
The shortest and best outline on the construction of a qanat is provided by Crowe et al. It says:
'The construction of a qanat makes a fascinating study. When a particular source of water is located, say at the foot of a mountain, a vertical master shaft is dug or drilled to the level of the water, which may vary considerably but does not usually exceed about 150 feet. The depth of the level of the water below ground is then gauged and the position of the outfall on a horizontal line is estimated by means of a series of horizontal alignments and drops along the surface. A line is then drawn between the master shaft and the point of outfall, and thence to the point where the water is to be used. This establishes the course of the qanat.
Following this line, a series of further vertical shafts is drilled, each at a distance of twenty or thirty yards apart along this line, to such a depth as to be in horizontal alignment with the level of water at the base of the master shaft. Finally, from the bottom of each shaft a tunnel is excavated to connect each length to the next, so as to extend from the outfall back to the source of water. Ultimately, a breakthrough is made on the last section, so that the water flows along the whole of the tunnel, discharging at the outfall. Here it is usually conducted into a channel, from which it is put to various uses. Normally, the horizontal tunnel is bored through the formation strata without support, but if the ground is exceptionally shaly

[2501] M. Brett: Marrakech in *Dictionary of the Middle Ages*; op cit; vol 8; pp 150-1.
[2502] Editor: Ma' (irrigation in North Africa and Spain) *Encyclopaedia of Islam*; op cit; vol 5; p. 877.
[2503] T. Glick: *Islamic*, op cit, p. 226.
[2504] A. Pacey: Qanats; in *Encyclopaedia* (Selin edt) op cit; p. 832.
[2505] T. Glick: *Islamic*, op cit, p. 226.
[2506] K. Sutton: Qanats in al-Andalus; op cit; p. 70.

or liable to subsidence, it may be necessary to line the excavation with brick, wood or tile. The tunnel is usually four to five feet in diameter.
Many qanats terminate in a tank or cistern from which water supplies for further uses may be drawn. But more commonly the water is conducted from enclosure to enclosure by straightforward gravity feed. Highly reticulated systems of waterways are built up until every drop is drained and used up.'[2507]
The Muslims refined the technique by using all known methods of mathematical calculation and engineering that had then become known to them.[2508]
Qanats were widely used through the Muslim land, from the Middle East to North Africa, to the Iberian Peninsula.[2509] The large city of Nishapur in Khurasan, for instance, was supplied entirely by qanats, most of which ran under the city and surfaced outside to form a river which irrigated the gardens of the area and many of the rural cantons.[2510] Some qanats, however, surfaced inside the city and provided water to buildings and gardens. The city of Rayy, near modern Tehran, also obtained its water for drinking and irrigation from qanats.[2511] At the other end of the Muslim world, the city of Tangiers was supplied by qanats from a great distance.[2512]
Throughout the centuries, the Islamic qanat system spread widely, stretching from the Castilian Meseta (Madrid) to Morocco, then as far as Central America.[2513] It can be traced today in the Algerian Sahara, and Oman.[2514] Today, with the introduction of new drilling techniques some qanats have become obsolete, but many communities still rely entirely on water supplied in this way.[2515] The widespread reliance on this system was primarily due to the fact that it saved considerable amounts of water from evaporation, and secured the transfer of water over considerable distances, even through arid deserts.[2516]

[2507] S. Crowe et al: *The Gardens of Mughal India* (Thames and Hudson; London; 1972), p. 32.
[2508] A.M. Watson: *Agricultural*, op cit, p. 107.
[2509] D.R. Hill: *A History of Engineering*; op cit; p. 36.
[2510] Ibid.
[2511] Al-Istakhri: *Kitab al-masalik;* op cit; p. 122.
[2512] Ibn Hawqal: *Kitab surat;* p. 79.
[2513] L. Bolens: Irrigation, in *Encyclopaedia* (Selin ed), op cit, p. 452.
[2514] J.C. Wilkinson: *The Organization of the Falaj Irrigation System in Oman*. School of Geography; University of Oxford Research Papers X (Oxford, 1974).
[2515] S. Crowe et al: *The Gardens of Mughal India*; op cit; p. 32.
[2516] L. Bolens: Irrigation, in *Encyclopaedia* (Selin ed), op cit, p. 452.

The success of such civil engineering projects owes to large extent to the advance in related scientific literature. Al-Kharaji (11th cent) treatise *Inbat al-miyah al-khafiyya* (The Extraction of Hidden Waters), for instance, deals with quantity surveying, that is, how to calculate the quantities of excavations for canals and hence derive the cost of the works in labour and in money. It, most importantly, describes instruments used by master well diggers and qanat builders, as well as methods of detecting sources of water and instructions for the excavation of underground conduits.[2517] It includes some very interesting chapters: Chapter 17, for instance, deals with the manner and methods of resolving physical obstacles hampering tunnelling of the ground. Chapter 18 covers the manner of water adduction by the means of conduits. Chapter 19 has recipes for sealing joints of conduits. Chapter 23 covers instruments for the purpose of civil engineering invented by himself (al-Kharaji). Chapter 25 explains how to construct an underground qanat, whilst chapter 26 tells how to maintain the horizontality of a tunnel at both ends of the qanat. Chapter 28 deals with the management of the qanat, and chapter 30 covers the specific rules and clauses that must be included in a contract with an underground tunnel digger.[2518]
There is also from Iraq the anonymous: *Kitab al-hawi li l-a'mal al-sultaniyya wa rusum al-diwaniyya* (Book Comprising Public Works and Regulations for Official Accounting).[2519] The lengthy second part of this work deals with levelling instruments and their use, and problems related to the construction and maintenance of canals, dykes and embankments.[2520] In the work three levelling instruments are included.[2521] The first is a wooden board about 70 cm long by 8 cm wide. In the centre of the board a line is drawn which meets both edges at a right angle; a plumb is fixed to this line, near one of the edges; two hooks are fixed to this edge. The second instrument consists of an equilateral triangle made of metal, with two hooks soldered to either end of its hypotenuse; a narrow hole is drilled through this side, to take the cord of a plumb line. The third instrument, called the 'reed level,' consists of a straight reed through which a narrow longitidunal hole is bored; in the centre, a radial hole is made into the bore.[2522]

[2517] D. R. Hill: *Islamic Science*, op cit, p. 187.
[2518] A. Mazaheri: Le Traite; op cit; pp. 300-1.
[2519] D.R. Hill: *Islamic Science*, pp 187-91.
[2520] Ibid; p. 187.
[2521] Description and use can be found in D.R. Hill: *A History of Engineering*; op cit; pp. 117-9.
[2522] Ibid; p. 117.

Equally revealing are Ibn al-Awwam's observations on levelling works to be undertaken before opening up canals, and Ibn Lujun of Almeira (14th century) studies on land levelling for the purpose of canal digging.[2523] Further information on studies of Muslim techniques of land levelling can be extrapolated from Wiedemann.[2524]

Muslim engineers also used triangulation techniques for the purpose of determining the heights and depths of objects, and the widths of obstacles such as large rivers by using the back of the astrolabe.[2525] Al-Biruni (d. 1050) and the Spanish Muslim, Ibn al-Saffar (d. 1035), describe the solution of various triangulation problems using the astrolabe.[2526] Many other problems are also solved by similar means, and they include finding the distance between two points separated by an impassable obstruction.[2527] Al-Kharaji devotes chapter 24 of his above mentioned work to an instrument for calculating the height of a mountain; the distance from it, or the height of any visible high point from the ground, without measuring it, and provides a demonstration for this.[2528]

Generally, Muslim science and practical knowledge in this subject passed intact to the Christian West, and generally via Spain. When the south of Spain was ultimately conquered by the Christians (1230s-1250s), they inherited a land highly developed in irrigation networks. Obviously they were at pains to preserve not only the works but also the framework of their operation and maintenance, thus in the edict by James the Conqueror of 1239, issued only one year after he had taken Valencia, the concluding lines of which go:

> 'And so you may irrigate with them (the canals) and take waters without obligation, service or tribute; and you shall take these waters, as was established of old and was customary in the times of the Saracens.'[2529]

[2523] Carra de Vaux: *Les Penseurs*, op cit, p. 183.
[2524] E. Wiedemann: *Beitrage zur Geschichte der Natur-wissenschaften. X. Zur Technik bei den Arabern*. Erlangen (1906).
[2525] See D. R Hill: *Islamic Science*, op cit, pp 198-202.
[2526] D.R. Hill: *A History of Engineering*; op cit; p. 120.
[2527] E. Wiedemann: *Ausatze zur arabischen Wissenschaftsgeschichte*; 2 vols; Olms (Hildesheim; 1970), vol 1; pp. 577-96.
[2528] A. Mazaheri: Le Traite; op cit; pp. 300.
[2529] In N. Smith: *The Heritage of Spanish Dams* (Madrid; 1970), pp. 13-4.

5. Water Lifting Devices:

Transferring water to a particular level or over long distances, for a diversity of purposes, such as irrigation, supplying water to private and public places, or pumping water out of flooded mines, has relied on a variety of water raising machines. These machines have constituted matters of focus for Islamic engineers. In relation to the latter cited problem, Al-Qazwini, the 13th century geographer, speaks of a mine where water was found at a depth of 20 cubits.[2530] To clear the water from the mine shaft a wheel was set on it and it served to force it up to a tank placed at a higher level. Here, the process was repeated and the water was pumped to a second tank, from which by means of another wheel it was raised to the surface.[2531]

A number of water lifting devices were either improved or developed by Muslim engineers, craftsmen, and users. These include the *shaduf* or swape, the *saqiya* or chain of pots, and the noria (a wheel driven by water) and pumps. There is no room here to dwell on the description of these devices beyond a couple of lines on their most central features. The saqiya, for instance, is a chain of pots driven through a pair of gear wheels by one or two animals harnessed to a draw bar and walking around a circular track.[2532] The chain of pots could also be driven by a treadmill, mounted on the same axle as the wheel carrying the chain of pots. The crux of this machine is the gear, which has the function of altering the motion from horizontal to vertical.[2533] There are plenty of references to the machine in the 10th century works of Islamic geographers,[2534] and there is a full description of the machine in the 17 volume encyclopaedia written by Ibn Sida who died in 1066.[2535] In the farming manual by Ibn al-Awwam, there is another description, which includes the interesting comment that the pot-garland wheel should be made heavier than is usual in order to make the machine operate more smoothly. This is a clear

[2530] Qazwini: *Athar al-Bilad*, in M.C. Lyons: Popular Science; op cit; p. 52.
[2531] Ibid.
[2532] D.R. Hill: *A History of Engineering*; op cit; p. 135.
[2533] Ibid.
[2534] Such as Al-Muqaddasi: *Ahsan al-Taqassim;* op cit; p. 208; Ibn Hawqal: *Kitab Surat al-Ard*; vol 2; p. 324.
[2535] E. Wiedemann and F. Hauser: Uber Vorrischtungen zum Heben von Wasser in der islamischen Welt; *Jahrbuch des Vereins Deutscher Ingenieure*; vol 8 (1918), pp. 121-54; p. 129.

indication that Ibn al-Awwam understood the principle of the fly-wheel.[2536] The use of the saqiya was introduced to the Iberian Peninsula by the Muslims, where it was massively exploited. Such diffusions continued, not only did Christian Spanish engineers take it to the New World, but it was also in use in the rest of Europe and in many places remained in use well into this century.[2537]

The noria is perhaps the most significant of the traditional water raising machines, being driven by water, it is self acting and requires the presence of neither man nor animal for its operation. There are excellent, detailed descriptions of this device, available in many works, such as Schioler's, for instance.[2538] Briefly, here, the noria is a large wheel driven by water. It is mounted on a horizontal axle over a flowing stream so that the water strikes the paddles that are set around its perimeter, and the water is raised in pots attached to its rim or in bucket like compartments set into the rim.[2539] The norias were widespread in the land of Islam, the water wheels of Hama, according to Sarton, being some of its great glories,[2540] and their descriptions by medieval contemporaries abound. The first such mention of them is in the work of Ahmad B. al-Tayyib in H 271/884-5.[2541] Nearly two centuries later, in 1047, the traveller Nasir Khusraw spoke of the numerous water wheels on the banks of the Orontes River.[2542] Al-Dimashqi, in 1300, also referred to the huge water wheels called Naurah, 'such as you see nowhere else,' and which raise the water from the river to irrigate the gardens.[2543] There were thirty two such wheels of various sizes, the tallest of which was 22 meters high, raising water to aqueducts which supplied both sections of the town and irrigating the surrounding gardens.[2544] When they arrived in the East, the crusaders were impressed

[2536] Ibn Al-Awwam Libro; op cit; in T. Schioler: *Roman and Islamic Water Lifting Wheels* (Odense University Press; 1973), p. 30ff.
[2537] N. Smith: *Man and Water;* op cit; p. 20.
[2538] T. Schioler; op cit; pp. 37-8.
[2539] D.R. Hill: Hydraulic machines; in *Encyclopaedia of Islam;* op cit; vol 5; under ma'a; p. 861.
[2540] G. Sarton: *Introduction;* op cit; vol 2; p. 623.
[2541] H. Suter: *Die Mathematiker und Astronomen der Araber und ihre Werke* (APA, Oriental Press, Amsterdam, 1982). p. 33.
[2542] Nasir Khusraw; p. 5. in G. Le Strange: *Palestine Under the Moslems* (Alexander P. Watt; London; 1890), p.357.
[2543] Al-Dimashqi: *Kitab nukhbat al-dahr fi ajaib al-barr wal bahr,* edited by A.F. Mehren; quarto, 375 p. (St Petersburg; 1866).
[2544] D. Sourdel: Hama; in *Encyclopaedia of Islam;* New Series; vol 3; pp. 119-21. p. 120.

by these wheels, and eventually they brought them to Germany where they are still used in a little valley in Franken near Bayreuth.[2545] Norias were widely used in Muslim Spain, too, at Cordoba a noria at one end raised and deposited water into an aqueduct which transported water into the city.[2546] The same in Toledo, where a wheel discharges into one end of an aqueduct that carries the water to the town and the fields, and whilst the largest Hama wheels had a diameter of 20 metres, and are an impressive sight, al-Idrisi informs us that that lift of the water wheel at Toledo was 90 cubits or about 50 metres.[2547]

Some Muslim engineers who designed or built such machines are known to us. Al-Jazari was amongst them. His designs contradict the generally established view amongst Western historians who assert that his devices, like those of other Islamic engineers, were mere fanciful creations with no practical purpose. His treatise contradicts such widespread distortions.[2548] Not only, it is almost certain that he was involved in the design and construction of public works, but his designs have also incorporated techniques and components that are of importance for the development of machine technology.[2549] One of his machines, a miniature water driven saqiya (category V; ch 3), was provided with a model cow to give the impression that this was the source of motive power, whilst the actual power is provided in a lower, concealed chamber and consists of a scoop wheel and two gear wheels.[2550] This system drives the vertical axle that passes up into the main chamber, where two further gear wheels transmit the power to the chain of pots wheel.[2551] Such devices, without the model cow, were in every day use, al-Jazari's model being a smaller version of a larger one, used on the River Yazid in Damascus, that was built not later than 1254 to serve the needs of a hospital and that has remained in constant use throughout the centuries until it fell into disrepair in 1960.[2552]

[2545] M. Sobernheim: Hama; in *Encyclopaedia of Islam*, 1st series, 1915; vol 2; pp. 240-1. p. 240.
[2546] N. Smith: *A History of Dams;* op cit; pp 90-1.
[2547] Al-Idrisi: *Description de l'Afrique du Nord et de l'Espagne;* Arabic text ed. With French Tr by R. Dozy and M.J. de Goeje (Brill; Leiden; 1866), p. 187 in Arabic, and 228 in French.
[2548] D.R. Hill: *The Book of Knowledge*, op cit.
[2549] D.R. Hill: *A History of Engineering*; op cit; p. 146.
[2550] D.R. Hill: Hydraulic machines; in *Encyclopaedia of Islam*; op cit; vol 5; p. 861.
[2551] Ibid.
[2552] D.R. Hill: *A History of Engineering;* op cit; p. 148.

Islamic history has also retained the name of a water wheel constructer: Qaysar (fl 12th-13th centuries) who is credited for building some gigantic wheels adorning the Syrian landscape,[2553] especially on the Orontos river.

Water raising devices are not just important, as outlined so far, for their economic and social roles, but are also important for another crucial reason. Indeed, as Hill points out, they are of considerable significance in the history of machine technology, since many of the ideas and components incorporated in such water lifting devices were to enter the vocabulary of European engineering at a later date.[2554] In one of Al-Jazari's devices, for instance, we have the crank as part of a machine, although manually operated cranks have been in use for centuries.[2555] In another of his machines, listed as al-Jazari's First Water Raising Machine, the segmental gear plays an interesting part.[2556] A similar wheel first appeared in Europe in Giovani De'Dondi's astronomical clock, completed about 1365;[2557] but this type of gear was already known in the Islamic world before the time of Al-Jazari, through al-Muradi (fl. 11th century) of Spain who used it in some of his devices.[2558] One of al-Jazari's devices, listed as his fifth machine, is a piston pump with two alternative means of propulsion.[2559] This piston pump played a leading role in the development of technology, and it is more advanced than the suction pumps that appeared in Europe in the 15th century, since it is self acting, and incorporates both a suction and a delivery lift, and the double action principle.[2560]

Another type of wheel was also widely used in Islam, but to provide power; water and wind playing a central role in activating machinery in Islam.

[2553] R.J. Forbes: *Studies in Ancient Technology*; vol II, second revised edition (Leiden, E.J Brill, 1965), p. 114.
[2554] D.R. Hill: *A History of Engineering*; op cit; p. 129.
[2555] Ibid; p. 149.
[2556] Ibid; pp. 147-8.
[2557] S. A.Bedini and F.R. Maddison: Mechanical Universe, the Astrarium of Giovanni de Dondi, *Transactions of the American Philosophical Society;* New Series; vol 56 (1966).
[2558] D.R. Hill: *A History of Engineering*; op cit; p. 148.
[2559] Ibid; p. 149-52.
[2560] Ibid; p. 152.

6. Water and Wind Mills:

Hill, in an observation on wind and water power touches upon the usual dismissive attitude to Islamic accomplishment. He says:

> 'We do now have a reasonably clear picture about the development of water based industries in medieval Europe from the 11th century onwards, but until now very little has been published on the situation in Islam. Some historians (nearly all, Hill should have said), assuming from the lack of available information that the Muslims made only limited use of water power, have constructed theories to explain this apparent lack of interest as being due to factors inherent in Muslim society. These theories are, however, based upon a faulty premise, since it can be demonstrated that the Muslims were anything but indifferent to the benefits to be obtained from the exploitation of water power.'[2561]

These generalised Western assumptions are erroneous, and the following will show that the use of water and wind mills was not just widespread in Islam, but also that every single innovation related to them took place centuries ahead of Western Christendom.

a. Water Mills:

Leading amongst Western historians in demeaning the role of water mills in the land of Islam is Lynn White Jr, who holds that:
'The lands of medieval Islam were generally so arid that, even where there was enough water for agriculture, the flow of streams was too scanty or sporadic to operate many mills to grind grain.'[2562]
Having stated this, Lynn White goes on to build his usual argument, why naturally powered mills developed in the Christian West. Of course, Lynn White is wrong, and on every single count.

There was a great deal of use of water to activate machinery in the Islamic world. This was done primarily through two varieties of water mills: the

[2561] Ibid; p. 154.
[2562] L. White Jr: Cultural; op cit; 175.

non geared horizontal mill, powered by a horizontal wheel with paddles (the ancestor of the turbine), connected directly to the bedstone by a shaft, and the vertical mill (either overshot or undershot), whose motive force is transmitted to the stone by a gearing mechanism.[2563]

Hill describes the wheels that activate such mills:

-The vertical undershot wheel is a paddle installed on a vertical axle over a running stream, and whose power is derived nearly entirely from the velocity of the water.

-The overshot wheel, also vertical on a horizontal axle, with rims divided into bucket like compartments into which water discharges, usually from an artificial channel.

-The Horizontal wheel, which can be sub-divided into two types. The first has curved or slanted vanes fitted to a central wooden rotor, and is mounted at the bottom of a vertical shaft and water from an orifice fitted to the bottom of a water tower is directed on to the vanes, the flow being thus tangential. The second type is a vaned wheel fixed to the lower end of a vertical axle, and is installed inside a cylinder into which the water cascades from above, turning the wheel mainly by axial flow.[2564]

Hill insists on the need to know about the origins of the horizontal wheels as they are the direct ancestor of modern day turbines.[2565] He holds that the second type of horizontal wheel was unknown in Europe before the 16th century, but appeared in the 9th century treatise of the Banu Musa brothers.[2566] This raises the interesting question, once more, of how did knowledge of such technology transfer between places. It also draws attention to the crucial element that will be raised recurrently in this chapter, that is the considerable number of technological innovations that appeared in the Islamic world centuries earlier than in the Christian West, completely contradicting the generalised assumptions found in Western history, which speak of innovations in Western Christendom, when these were already made centuries earlier. In relation to vertical mills, for instance, these were introduced by the Muslims in Spain, and they were used for the milling of grain and for industrial uses.[2567] The vertical mill diffused northwards into Castile, with the name *acena* (from Arabic *saniya*) which always denotes verticality in medieval Castilian

[2563] T. Glick: *Islamic,* op cit, p. 230.
[2564] D.R. Hill: *Islamic*, op cit, pp. 105-9.
[2565] Ibid; p. 110.
[2566] Ibid; p. 110 ff.
[2567] T. Glick: Irrigation and Hydraulic Technology in Islamic Spain; Methodological Considerations; in *Irrigation and Hydraulic Technology* (Variorum; Ashgate; Aldershot), pp. 1-20; at p. 16.

documentation.[2568] Not only were *acenas* semantically differentiated from horizontal mills, but their geographical distribution followed a characteristic pattern, with acenas located on large rivers and horizontal mills on smaller streams, owing to the different hydraulic requirements of each.[2569]

Another instance which highlights both Islamic advance on the Christian West, and on its predecessors, relates to the use of the overshot mill wheel, in which the water is conducted through a channel to the top of the wheel, which has bucket like compartments around its rim.[2570] The overshot wheel works mainly by the weight of the water, whereas the Vitruvian one is operated by its force. In many conditions, the former is the more efficient of the two,[2571] its use recommended by al-Muradi (11th century).[2572] The geographer al-Dimashqi (d. 1327) describes one such wheel in operation near Tabriz.[2573] The advantages of the overshot wheel were well documented by Muslims. The 13th century geographer, al-Qazwini (d. 1283), quotes an earlier lost passage from al-Udhri, that says that when water is scarce, vertical wheels could be converted from undershot to overshot wheels. The passage reads:

> 'When the water which moves it is scarce they take a thick log of some ten palms in circumference by seven cubits long. They saw it into two halves and hollow out each half from one end up to half a cubit before reaching the other. Both pieces are joined and in the solid end they make a hole as wide as a donkey's hoof. They erect it over the canal so that the end which has the hole rests on the wheels; the water exits forcefully through the hole in the log, strikes the teeth of the wheel, and the mill begins to turn.'[2574]

[2568] Ibid.
[2569] Luis Miguel Villar Garcia: *La Extramadura castellano-Leonesa: Guerreros, clericos y compesinos (711-1252)* (Valladolid; 1986), p. 335; note 123.
T. Glick: Irrigation and Hydraulic Technology; p. 16.
[2570] D.R. Hill: Hydraulic Machines; op cit; p. 861.
[2571] Ibid.
[2572] D.R. Hill: A Treatise on Machines; in *Journal of the History of Arabic Sciences;* Aleppo; 1977; vol 1; pp. 33-46.
[2573] Al-Dimashqi: *Kitab nukhba.*; op cit
[2574] Al-Qazwini: *Kosmography*; ed Wustenfeld; II; p. 381; see comments on this mill by E. Weismann: Uber Arabisches, eigentumliches Wasserad und eine kohlenwasserhaltige Hohle auf Mallorca nach al-qazwini; *Mitteihungen zur Geschchite…* 15; 1916; 368-70; also see: Jose Alemany Bolufer: *La geografia de la Peninsula Iberica en los escritos arabes (*Granada; 1921); p. 135, all in T. Glick: Irrigation and Hydraulic Technology in Islamic Spain; Methodological Considerations; in *Irrigation and Hydraulic Technology*; op cit; at p. 17.

The overshot wheel did not come into generalised use in the West until about the 14th century.[2575]

Muslims mastered the use of water mills not just centuries ahead of the Christian West, and not just in isolated regions, as usually stated, but throughout the land of Islam, where they were used in great numbers. The 10th century geographer, Al-Muqaddasi, for instance, speaks of the 'wonderful mills on the water;' near Nishapur in Khurasan, where there were seventy of them on the river.[2576] One description of the Kur River dam in central Asia, mentions ten water wheels in the vicinity driving mills.[2577] Bukhara was noted for the number of its mills driven by undershot wheels.[2578] There were many corn mills in Tabaristan, too.[2579] To the west, in Egypt, the town of Bilbays, on the eastern branch of the Nile in lower Egypt, was an important grain processing centre, the many mills there grinding corn for export to the Holy cities of the Hijaz. Al-Muqaddasi estimated that the annual output of grain and flour amount to 3,000 donkey loads (say 300 tons).[2580] In North Africa, 400 mills (also including wind-mills) were seen in Fes in the year 1184.[2581] The Repartimento of Majorca, following its capture from the Muslims, documents 162 mills, and Miquel Barcelo estimates that just before the Christian conquest of 1229, there were around 197 mills in all.[2582] There were also references to mills in places such as Jaen and Merida.[2583] In 10th century Palermo, then under Muslim rule, the banks of the river were lined with mills.[2584] And the instances could be multiplied. Such was, one could say the Muslim obsession and expertise in water mills, as Hill points out, Islamic engineers would evaluate the number of mills a water way would activate on first sight.[2585] In fact, medieval Muslims saw each

[2575] D.R. Hill: Hydraulic Machines; op cit; p. 861.
[2576] Al-Muqaddasi: *Ahsan al-taqasim fi Marifat al-Aqalim*,' in A.F. Klemm: *History of Western Technology*; tr by D.Waley Singer (George Allen and Unwin Ltd, London, 1959), p. 79.
[2577] A. Pacey: *Technology in World Civilisation*; op cit; p. 10.
[2578] Al-Muqaddasi: *Ahsan al-Taqasim*; op cit; p. 280.
[2579] D.R. Hill: *A History of Engineering*; op cit; p. 164.
[2580] Al-Muqaddasi: *Ahsan al-Taqasim;* op cit; p. 195.
[2581] A. Djebbar: *Une Histoire;* op cit; p. 350.
[2582] Miquel Barcelo: Els molins de Mayurqa; *Les Iles orientales d'Al Andalus* (Palma de Mallorca; 1987), pp. 253-62.
[2583] Al-Muqaddasi: *Ahsan al-Taqasim,* op cit; p. 234; and Al-Idrisi: Descritpion; op cit; Fr. Version; p. 183.
[2584] Ibn Hawqal: *Kitab surat al-Ard*; op cit; p.222.
[2585] D.R. Hill: *Islamic Science*, op cit, p. 110.

water way not just in terms of its agricultural benefits, or poetical inspiration, but always looked at it from the perspective of how many mills it would generate. Thus, al-Muqaddasi looking at the Tigris at its source estimated that it would turn one mill,[2586] and al-Istakhri looking at a fast flowing stream in the province of Kirman, estimated it would turn 20 mills.[2587]

Smith points out that just as in Europe, water power in the Islamic world was applied at first to raising water and grinding corn but was gradually extended to such works as sugar cane crushing, fulling and paper making.[2588] In a treatise on mineralogy, written between 1041 and 1049, Al-Biruni (d.ca 1050) gives the following description:

> 'The gold may be combined with stone [i.e ore] as if it were cast with it, so that it needs pounding. And mills pulverise it, but pounding it by *mashajin* is more correct and refined treatment-it is even said that this increases its redness, which if true is strange and surprising. The *mashajin* are stones which are fixed to axles that are erected across running water for pounding, as is the case in Samarqand with the pounding of flax for paper.'[2589]

The process in paper making, using water power, is explained by Derry, Williams and Hill. They tell us that raw materials for paper included straw and wood as well as linen and cotton, and the first task was to beat the material to a pulp and mix it with water to disperse the fibres.[2590] This was expedited by the stamp mill, using a wheel and tappets to raise and drop pestles in mortars. The mill was at first turned by hand but later by water (or wind) power.[2591] The mills used trip hammers operated by vertical undershot water wheels that pounded the raw material (linen, flax or hemp rags).[2592]

Water power was used in other manufacturing processes. Pacey observes that a new type of mill had been introduced in Iran and Iraq for processing sugar cane, as crushing the cane and then boiling the extract were the main operations necessary for obtaining crystalline sugar.[2593] In many recent surveys in the Jordan Valley, the remains of 32 water powered

[2586] Al-Muqaddasi: *Ahsan al-Taqasim;* op cit; p. 136 ff.
[2587] Al-Istakhri: *Kitab al-masalik*; op cit; p. 166.
[2588] N. Smith: *Man and Water;* op cit; p. 142.
[2589] Al-Biruni: *Kitab al-Jamahir fi ma'arifat al-Jawahir*; ed. F. Krenkow (Hyderabad; Deccan; 1936), pp. 233-4.
[2590] T.K Derry and T.I Williams: *A Short History of Technology* (Oxford Clarendon Press, 1960), p.233. D.R. Hill: *Islamic Science*; op cit; pp. 112-3.
[2591] Ibid.
[2592] Ibid.
[2593] A. Pacey: *Technology;* op cit; p. 10.

sugar mills, dating from the Ayyubid-Mamluk period, have been recorded.[2594] Applications of water wheels developed by the Muslims were also for fulling woollen cloth.[2595] Ibn al-Balkhi, writing in 1107, calls a newly restored dam on the river Kur in Iran by the name of Band I-Qassar, meaning 'fullers' dam,' an indication that its impounded water provided power for fulling mills.[2596] Writing in the first half of the 12th century, the historian Ibn al-Asakir mentions the use of water for sawing timber.[2597]

One variation between Islam and the Christian West was the occasional use of dual purpose water wheels: norias used to drive the grinding stones of grist-mills.[2598] The main difference, though, still remains in timing, Islamic water powered mills being centuries ahead of those of Western Christendom. Water powered cane crushing mills are known to have existed in Basra and other places in the 9th century, and Al-Biruni describes how such water powered mills worked, and how water power was used in driving trip hammers for paper mills in Samarkand and in crushing gold ores.[2599]

Generating hydro power in contrasting environments, using appropriate techniques, is further evidence of Islamic technological ingenuity. Hence, in an effort to improve the performance of horizontal and undershot water wheels, Islamic engineers were among the first to use river dams, generally not very large, to increase the velocity of flow and provide a measure of flow control.[2600] Hydro power dams were especially numerous on rivers such as the Karun, Kur, Helmund and Oxus in the eastern caliphate and on the Guadalquivir in Spain.[2601] In Khuzistan, the mills were placed in tunnels cut through the rocks at each side of the channel, which constituted an early example of hydro power dams.[2602] A great deal of power was derived from the Guadalquivir river passing through Seville and Cordova and linking them with the sea, by means of water wheels mounted on the banks, on floating barges and within or at least supplied

[2594] S. Hamarneh: Sugar-cane plantation and industry under the Arab Muslims during the Middle Ages; in *Proceedings of the First International Symposium for the History of Arabic Science* (Aleppo University; 1976), p. 221.
[2595] A. Pacey: *Technology;* op cit; p. 10.
[2596] In N. Smith: *A History of Dams;* op cit; p. 85.
[2597] Ibn Al-Asakir, mentioned in D.R. Hill: *A History of Engineering*; op cit; p. 170.
[2598] N. Smith: *Man and Water*; op cit; p. 142.
[2599] In A.Y. Al-Hassan: Technology; Islamic; in *Dictionary of Middle Ages*; op cit; vol 11; pp.636-40; at p.637.
[2600] N. Smith: *Man and Water;* op cit; p. 142.
[2601] Ibid.
[2602] N. Smith: *A History;* op cit; p. 81.

from dams.[2603] One of these dams still stands across the river at Cordova just below the Puente Romano, and until quite recently its three mill houses (al-Idrisi says that each contained four water wheels) were still functioning, but much altered from their original form.[2604] In places, where the banks of the watercourse were high, as for instance, along the Euphrates, at Hama on the Orontes, at Amasia on the Yeshil Irmak, or at Toledo in Spain, the current of the river itself was used to turn waterwheels, which produced energy for flour and paper mills.[2605] Water mills were also installed between the peers of bridges to take advantage of the increased rate of flow caused by the partial damming of the river.[2606] Where the flow of water was not strong enough to work the mill, the stream was forced through a hollowed beam with narrow apertures at its end so that the water might come out in a jet and thus turn the mill wheel.[2607] Tidal mills were also frequent, such as at Basra, where mills were operated by ebb tide. 'The ebb tide is so useful for operating the mills because they are at the mouths of the rivers, and when the water comes out it turns them.'[2608] Ship-mills were equally widely used to take advantage of faster currents in midstream and to avoid problems caused by fixed mills especially during the dry season.[2609] Floating mills were mounted on floating platforms on the Spanish Ebro river at Saragoza, and on the Segura at Murcia.[2610] Many 10th century cities on the Euphrates and the Tigris had floating mills.[2611] The people of Mosul erected water wheels on the Tigris and they also used to anchor floating mills in the river.[2612] These mills were very large, made of teak and iron, and were moored to the banks by iron chains.[2613] A 10th century observer describes such mills:

> 'The ship mills on the Tigris at Mosul have no equal anywhere, because they are in very fast current, moored to the bank by iron chains. Each has four stones, and each pair of stones grinds in the day and night 50 donkey loads. They are made of wood and iron-sometimes of teak. At Balad, not far from Mosul, there were a large number of these working to supply Iraq… There were a

[2603] N. Smith: *Man and Water*; op cit; p. 143.
[2604] Ibid.
[2605] G. Wiet et al: *History;* op cit; p. 312.
[2606] D. R .Hill: *Islamic Science,* op cit; p. 111.
[2607] M.C. Lyons: Popular science; op cit; p. 52.
[2608] Al-Muqaddasi: *Ahsan al-taqasim*; op cit; pp. 124-5.
[2609] D.R. Hill: *Islamic Science*; op cit; p. 111.
[2610] V. Lagardere: Moulins d'Occident Musulman au Moyen Age (9em au 15 em Siecle): Al-Andalus, in *Al-Qantara*; Vol 12 (1991) pp 59-118. at p. 61.
[2611] R.J. Forbes: *Studies;* op cit; p. 114.
[2612] M.C. Lyons: Popular Science; op cit; p. 52.
[2613] D.R. Hill: *Islamic Science*, op cit, p. 111.

> certain number of them on the Tigris at Haditha; the revenue was about 50,000 Dinars.'[2614]

In the year 1183, Ibn Jubayr informs us that in Upper Mesopotamia, ship mills across the River Khabur, formed, as it were, a dam.[2615] The large scale milling was necessary if we consider the demands from a city such as Baghdad, whose population was estimated at 1.5 million at the time.[2616] Once more, many such techniques followed in the Christian West centuries after Islam, the oldest illustration of a floating mill in the Christian West, for instance, is in a French manuscript of 1317, which shows the boats tied up between the piers of a bridge across the Seine in Paris, an arrangement which was in use as early as the 12th century (during the reign of Louis VII, 1137-80).[2617]

Wind Power:

Just as with water power, mainstream Western historians, again led by Lynn White, claim, that windmills were never diffused in Islam.[2618] Historical evidence, once more, shows the very opposite.

Wind-power was widely used in Islam to run mill stones and also to draw up water for irrigation.[2619] This began as early as the reign of Caliph Omar (634-44);[2620] a pioneering role emphasised by Carra de Vaux.[2621] Windmills were widespread east of the Islamic land, most particularly in 'Sedjestan,' where the people, according to Al-Masu'di (d. c. 957), use wind to operate their mills and raise water from wells.[2622] His contemporary, Al-Istakhri, too, noticed how the wind blows without interruption and operates mills erected everywhere.[2623] Al-Qazwini

[2614] Ibn Hawqal: *Kitab Surat;* op cit; p. 219.
[2615] Ibn Jubayr: *Rihla:* op cit; p. p.243.
[2616] A.A. Duri: Baghdad; *Encyclopaedia of Islam*; vol 1; p. 899.
[2617] N. Smith: *Man and Water*; op cit; p. 143.
[2618] Lynn White Jr: *Technology in the Middle Ages*; op cit; p. 77.
[2619] G. Wiet et al: *History;* op cit; p.312.
[2620] Al-Tabari: Selection from the Annals (edit. de Goeje, Leiden, 1902, p. 1, in R.J. Forbes: *Studies in Ancient Technology*; op cit, p. 116.
[2621] Carra de Vaux: *Les Penseurs;* op cit, p. 190.
[2622] Al-Masudi: Meadows of gold, vol ii, p. 80; in Carra de Vaux: *Les Penseurs*, op cit, p. 191.
[2623] Cited by Yaqut: Dictionary of Persia, p. 301, in Carra de Vaux: *Les Penseurs*, op cit, p. 191.

(d.1283) refers to the grinding of corn by such windmills.[2624] His contemporary, Al-Dimashqi (d. 1326-7), describes and makes sketches of such windmills.[2625] He also gives explanatory notes.[2626]

There are modern descriptions of the Islamic windmills. Khanikoff describes the windmill in Seistan in the following terms:

> 'A millstone is attached to the end of a wooden cylinder, half a metre wide, and 3.5 to 4 metres high, standing vertically in a tower open on the north east side to catch the wind blowing from this direction. The cylinder has sails made of bundles of ush or palm leaves (which reminds of the modern European windmill), attached to the shaft of the axle. The wind, blowing into the tower, exerts strong pressure on the sails, so turning the shaft and millstone.'[2627]

Forbes provides further outline on the operation of the mill,[2628] whilst Wiedemann gives the sketch the 14th century windmill,[2629] clearly showing the mill above and the sails on the lower levels. Early Islamic windmills did include two storeys; in the upper storey were placed the millstones, and in the lower one, a wheel driven by the sails-six or twelve in number and covered with fabric-which turned the upper millstone.[2630] Much more detailed description is given by Hill.[2631] The windmills were erected on substructures built for the purpose, or on the tower of castles or on hilltops. The upper chamber was for the millstone, and the lower one for the sails. The walls of the lower chamber were pierced by four vents with the narrower end towards the interior, like the loopholes of a fortress so as to direct the wind on to the sails, and increase its speed.[2632]

With regard to the matter of impact, here, again, there are serious problems with mainstream Western historians. Bradford Blaine, for instance, says:

Al-Istakhri, himself, a 10th century Muslim scholar, was only translated in the mid 19th century:
-Al-Istakhri: *Das Buch der Lander*, tr. A.D. Mordtmann (Hamburg, 1845).
[2624] Al-Qazwini, *Works* (ed. Wustenfeld, Cottingen, 1849), vol II, p. 134. in R.J. Forbes: *Studies*, op cit, p.116.
[2625] Al-Dimashqi: *Manuel de la cosmographie arabe*, tr. A.F. Mehren, (Amsterdam. 1964).
[2626] Al-Dimashqi: M*anuel;* p. 246, in R.J. Forbes: *Studies*; op cit; p 117.
[2627] Khanikoff cited in G. Wiet et al: *History*; op cit; p. 312.
[2628] R.J. Forbes: *Studies*, op cit, pp 117-9.
[2629] E. Wiedemann: *Beitrage;* in A F. Klemm: *History;* op cit; p. 78.
[2630] T.K Derry and T.I Williams: *A Short History;* op cit; p. 254.
[2631] D.R. Hill: *Islamic Science*, op cit, pp 114-6; D Hill: Engineering, op cit, p 784.
[2632] D.R. Hill: *Islamic Science*, op cit, p. 116.

> 'Windmills first appeared in Europe in the late twelfth century in Leicestershire in 1137… followed by rapid proliferation elsewhere. By the 1190s German crusaders were building windmills in Syria… What inspired their development is not certain.. The distinctive Western model appears to have been an independent invention, possibly suggested by the mechanical principles and efficient production associated with the familiar water mill in which the vertical wheel turned the horizontal drive shaft.'[2633]

Hence, in his view Western Christendom impacting on Islam. This is wrong on many accounts. Never mind the fact that windmills appeared in the 7th century in the Islamic world during the rule of Caliph Omar (634-44), thus centuries before they appeared in the West. The focus here is on the point of the Germans carrying East this innovation. It makes no sense simply because White quotes the date for their spread in Europe: 1185 and after.[2634] Now, the Germans were part of the first crusade (1095-6) and played a predominant role during the second crusade (1147-8) (Conrad III of Germany was one of the three main leaders of the crusade), so the question to ask is: how could they take something East, which was not even diffused in their own country at the time.

Wiet et al, despite their reluctance to accept Islamic influences on subsequent European techniques, did accept localised impact in the Iberian Peninsula (10th century Catalonia), the Greek islands, and other Mediterranean regions where water was too scarce for milling.[2635] Hill notes the absence of windmills in Europe before the end of the 12th century. To him, even if European mills were not inspired by Muslims in their design, the idea of using wind as a source of power came from the Muslim world.[2636] Carra de Vaux points out that in Europe, the oldest text in relation to windmills is a French act of 1105 granting a religious community the right to establish one of these apparatuses, called *molendinam ad ventum* (moulin a vent in French: windmill in English).[2637] Which coincides exactly with changes in other areas of European life: new construction techniques, methods of warfare, manner of dress etc, which coincide exactly with the return of the first crusaders from the East

[2633] Bradford. B. Blaine: Mills; *Dictionary of the Middle Ages*; op cit; vol 8; pp. 390-5; at p. 394.
[2634] L. White: Cultural; op cit; pp. 175-6.
[2635] G. Wiet et al: *History*; op cit; p. 350.
[2636] D.R. Hill: *Islamic science*, op cit; p. 116.
[2637] Cited in Magasin Pittoresque, t. XX, 1852, p. 50. In Carra de Vaux: *Les Penseurs;* op cit, p. 190.

(the first crusade was launched in 1095), all manners of influence due to the crusades, which Prutz has expertly studied.[2638]

7. Further Misconceptions About Islamic Technology:

Munro states:

> 'Islamic (technological) treatises were written mainly by engineers employed in the courts of the great Muslim caliphs. These lavishly illustrated treatises were devoted almost exclusively to the construction of ingenious mechanical devices (hiyal) and automata designed to provoke wonder and aesthetic pleasure; and that 'Arabic' treatises on technology, like those of the Alexandrian school, displayed little interest in practical applications.'[2639]

And, yet, a little further on, Munro also holds that Islamic technology:

> 'May seem frivolous to some modern Western observer, but the designers of hiyal may actually have made significant contributions to the development of modern science and technology.'[2640]

Which reflects how historical evidence contradicts held assumptions, of which Munro, like many others is victim. (To his credit, though, Munro corrects many such assumptions in his outline on the subject, and offers plenty of good information.)

On the matter of triviality of Muslim mechanical devices, which is found amongst nearly every writer on Muslim mechanics, Hill notes that many of such devices seem, indeed, apparently trivial, yet, a number of ideas, techniques and components in them were crucial to the development of machine technology; and the influence of fine technology on the industrial revolution was even more important from a technical point of view than other machines.[2641] He recognises that Islamic fine technology embraces a whole range of devices and machines dedicated to a variety of purposes,

[2638] H. Prutz: *Kulturgeschichte der kreuzzuge* (Berlin, 1883).
[2639] J.H Munro: Technology treatises; op cit; p. 641.
[2640] Ibid; p. 642.
[2641] D.R. Hill: *Islamic Science*, op cit, pp 122-3; and D. R. Hill: Engineering, op cit, p. 784

and what these machines and devices have in common is the considerable degree of engineering skill required for their manufacture, and the use of delicate mechanisms and sophisticated controls.[2642]

Islamic technology, furthermore, like every single Muslim science, had a practical end; Islamic devices used for as wide purposes as pearl fishing, protection in polluted wells, clepsydre used to regulate irrigation time with extreme accuracy through the year,[2643] etc. On the heavier side of machinery, the same concern for practicality was also in force, water lifting devices, for instance, used for irrigation, whilst other machinery was used for crushing sugar cane and for extracting vegetable oils.[2644] Al-Hassan, in his edition of Taqi al-Din (Taqi Eddin), also points out that the Muslim engineer, from the early days of Islamic civilisation, used his skills and knowledge to build cities and dams, projects for irrigation, and in making machinery that had a wider public use.[2645] Colish also notes:

> 'There is another dimension to Muslim science that must be noted along with the indubitable creative achievements of its golden age. The Muslims were interested in selected fields and in particular problems... In each case, the subject was appealing because it had practical applications. Pure scientific theory, the lure of scientific knowledge for its own sake that had animated ancient Greeks, was not.'[2646]

The generalised view by Duhem, Clagett, Lynn White Jr, Gimpel (all referred to already), and their followers, that is nearly all historians of technology, is that Islamic technology bequeathed little to modern science.[2647] This is compounded by the other generalised assertion that Muslim technology is a mere borrowing from others. Scrutiny of historical evidence, however, shows the complete reverse of these assertions as is summed up at length here.

First, it is certain that Muslim engineers acquired some of their ideas and skills from the Chinese, Indians, and Byzantines a borrowing that fits with universal technical and technological evolution, but the Muslims made

[2642] Ibid.
[2643] L. Goonalons: La Clepsydre de Beni Abbes, in *Bulletin d'Etudes Arabes,* vol 3 (1943), pp 35-7.
[2644] C. Ludlow and A. Bahrani: Mechanical Engineering; op cit; p. 83.
[2645] In A.M. Hassani: Arab Scientists revisited; op cit; p. 139.
[2646] M.L Colish: *Medieval Foundation of the Western Intellectual Tradition*: 400-1400 (Yale University Press; 1997), p.136.
[2647] See Lynn White Jr (already abundantly referred to); P. Duhem: *Le System du Monde* (Paris; 1914). M. Clagett: *The Science of Mechanics; op cit;* J. Gimpel: *The Medieval Machine*; op cit; and their countless followers.

considerable improvements and innovations of their own.[2648] Devices that are found in individual Muslim engineering works show a considerable and decisive spirit of innovation.[2649] More importantly, as with many technological breakthroughs in the diverse fields that have already been observed, many such Islamic breakthroughs were centuries ahead of those of Western Christendom. In the Banu Musa's *Kitab of Hiyal* (Book of Ingenious Devices)[2650] there are descriptions of about a hundred or so devices revealing mastery of aerostatic and hydrostatic pressures, and the use of automatic control and switching systems.[2651] Designs are much more sophisticated than anything that had appeared earlier; most particularly the preoccupation with automatic controls and the use of self-operating valves, timing devices, and delay systems which distinguish their mechanical ingenuity from their predecessors (Hero and Philo).[2652] The Banu Musa's extensive use of conical valves as automatic controls in hydraulic transmission system, for instance, is centuries ahead of similar use in Western Christendom, conical valves first appearing in the works of Leonardo da Vinci.[2653] Al-Muradi's 11th century treatise on machines *Kitab al-asrar fi nata'ij al-afkar* (Book of Secrets of the Results of Thoughts) includes the usual models of water clocks and automata, but also large machines with powerful prime movers.[2654] Al-Muradi's machines show segmental and epicycle gears used to transmit high torque, which is at least three centuries earlier than anything similar appearing in Western Christendom.[2655] Al-Muradi's machines also show his use of mercury in some sort of balancing system, mercury being used in several types of Islamic devices.[2656] Equally, Al-Jazari's machines, mechanisms and techniques were so advanced they became, centuries after him, part of European mechanical engineering.[2657] From his treatise can be derived ingenious applications of conical valves, tipping buckets, and segmented gears; double acting pumps with suction pipes and the use of a crank shaft in a machine, accurate calibration of orifices, lamination of timber to minimize warping, static balancing of wheels, use of paper models to establish a design, casting of metals in closed mould boxes with green

[2648] C. Ludlow and A. Bahrani: Mechanical; p. 83.
[2649] See A.Y. Al-Hassan, and D. R. Hill: *Islamic Technology*.
[2650] Banu Musa: *The Book of Ingenious Devices; op cit.*
[2651] D.R. Hill: Arabic Fine Technology, op cit, p. 27.
[2652] J.H. Munro: Technology; op cit; p. 641.
[2653] D.R. Hill: *A History of Engineering*; op cit; p. 212.
[2654] J.H. Munro: Technology; op cit; p. 642.
[2655] D.R. Hill: *A History of Engineering*; op cit; p. 203.
[2656] Ibid.
[2657] D.R. Hill: Arabic Fine Technology; op cit; p. 27,

sand etc.[2658] The preoccupation with automata that can be found in great measure in Al-Jazari (and the Banu Musa) was, Munro insists, one of the factors that led to the development of rationalistic, mechanistic explanations of natural phenomena.[2659] Centuries after al-Jazari, Taqi Eddin's treatise: 'The Sublime Methods of Spiritual machines' contains descriptions and illustrations of weighing equipment, pumps, and water turbines, and various other machines, of equal high interest and impact.[2660] Taqi Eddin describes sophisticated pumps such as the screw pump, rag and chain pump, and the six cylinder-piston pump.[2661] Al-Hassan (the editor of Taqi Eddin's treatise) shows the great significance of the opposed two cylinder pump in Taqi Eddin (p.32 of the text), a machine, first described by al-Jazari in the 13th century, that was the basis from which the steam engine developed.[2662] Al-Hassan also argues that Taqi Eddin's description of the screw pump appeared in the period 1551-2 just when Western descriptions of the kind appeared, and that Taqi Eddin also preceded Agricola whose description of a rag and chain pump first appeared in *De re metallica* in 1556, and also that a similar design of lead weights used by Taqi Eddin was adopted by Morland in 1675.[2663]

Secondly, going further than both its predecessors and successors, Islamic technology did not limit itself to the making of the devices, but also included information on how they were assembled and their operation in minute detail; design and method of manufacture taking central role.[2664] Unlike their Greek predecessors, Muslim engineers were also aware of the value of experiment, and often constructed models and prototypes of their devices.[2665] The Muslim engineer, as Taqi Eddin reminds us, had also to be skilled in the science of geometry and measurement and to be conversant with the various crafts such as forging, casting and welding.[2666] Thus, Al-Jazari's great contribution, as Hill notes, was carefully to describe each phase of the construction process, specifying measurements, procedures, and the materials used so as to enable future craftsmen to reconstruct his machines.[2667] And, indeed, many of his devices were constructed

[2658] D. R. Hill: Engineering, op cit, pp 791-2; and J.H. Munro: Treatises; at p.642.
[2659] J.H. Munro: Technology, op cit; p. 642.
[2660] C. Ludlow and A. Bahrani: Mechanical Engineering; op cit; p.79.
[2661] In A.M. Hassani: Arab Scientists revisited; op cit; p. 139.
[2662] Ibid.
[2663] Ibid.
[2664] C. Ludlow and A. Bahrani: Mechanical: op cit; p. 83.
[2665] Ibid; p. 81.
[2666] Ibid.
[2667] J.H. Munro: Treatises; op cit; p. 641.

following his instructions.[2668] Other writers either fail to give sufficient details, as they were not craftsmen themselves, or if craftsmen, could have been illiterate[2669] (or were just selfishly motivated, seeking to protect their craft).

Taken as a whole, Muslim makers of hiyal (ingenious devices) also made important contributions to the development of machine design, the outcomes of which, among other things, are vending machines, mechanical calculators, and the modern computer.[2670] As a whole, Muslim engineers were also first in using segmental gears, sinking floats serving as actuators and many hydraulic devices.[2671] If one focuses on just the matter of gears with Hill,[2672] looking at Islamic treatises, one will find that all the combinations of gears appear in the automata treatises: parallel meshing; meshing at right angles; worm-and-pinion; rack-and-pinion. Segmental gears, for instance, appear in al-Muradi and al-Jazari and epicycle gears in al-Muradi. Larger wheels were usually made of wood, the teeth formed from pegs fixed around the perimeter; for parallel meshing one of the gears was often a lantern pinion. Smaller gears were made from copper or bronze, the teeth filed to the shape of equilateral triangles. In automata and water clocks gears were rarely used in the main transmission system; their use was confined to peripheral mechanisms-pulley-trains were commonly used for transmitting power. Al-Muradi's treatise, for instance, showed three unique features: epicycle gears, the use of gears to transmit power, and the fact that the gear-wheels were all made of metal.[2673]

This author browsing through a review of Carter's work on printing,[2674] could not fail to come across another generalised flawed opinion amongst historians of technology, in regard to the history of printing, as in Carter's heading 15: 'Islam as a barrier to printing,' where he says:

> 'The Muslims are strongly prejudiced against printing: with the exception of the abortive project of 1729 at Constantinople, the Islamic world never printed a book till 1825, when the first press was set up at Cairo. The Muslims who remained for half a

[2668] D. Hill: Engineering; op cit; p. 789.
[2669] Ibid.
[2670] J.H. Munro: technology; op cit; p.642.
[2671] C. Ludlow and A. Bahrani: Mechanical Engineering; op cit; p. 83.
[2672] D.R. Hill: *A History of Engineering*; op cit; p. 208.
[2673] Ibid.
[2674] Review of T. F. Carter: *The Invention of Printing in China and its Spread Westward;* New York; 1925. in *ISIS*; vol 8 (1926), pp. 367-72.

> millennium the best agents in the distribution of paper, were, on the contrary, antagonistic to the diffusion of printing. This diffusion was thus largely stopped until the Muslim barrier had been penetrated from the East, by the Mongols, and from the West, by the crusaders.'[2675]

Then, one reads under heading 18: 'Block printing in Egypt during the period of the Crusades':

> 'Some fifty fragments of block printing included in the enormous collection of documents found near Crocodiloponis in 1800... fragments dating from c.900 to 1350, all of religious nature. Considering the technique, the religious subject matter and the materials used, also the fact that Egypt was under Turkish influence from the 9th century on, it is probable that this Egyptian printing was a development of Asiatic printing.'[2676]

There are a number of contradictions and fallacies in these two quotations by Carter. First, the second quotation contradicts the first. The first says Islam is against printing, and the second says fragments dating from c.900 were found in Egypt. In 900 Egypt was under Islamic rule. Secondly, it is said under the first heading that the hostility of Islam to printing was broken by the arrival of the Crusades (late 11th –13th century, and the Mongols 13th century), which contradicts the statement that printing arrived in the 9th century (the fragments found in Crocodiloponis). Thirdly, if hostility to printing was already broken by both crusaders and Mongols (11th-13th century), why then say such hostility lasted until 1825 (heading 15). Fourthly, Egypt, with North Africa and the Arab Peninsula, was the only place that never fell to either Mongol or crusader rule, hence the assertion that the crusaders and Mongols were responsible for breaking the Islamic barrier to, and diffusion of, printing is non-sense.

Another flawed assumption is that Islam is a brake to technological innovation. The intricate link between the Islamic faith and technology is proven by the fact that adequate practice of the faith relies on advanced technological know how, the Muslims, for instance, needing to know the time of day to keep the five daily ritual prayer sessions, and for this purpose, they had sundials, clepsydras, sand clocks and mechanical clocks.[2677] The religious dimension also worked on another level as told by Al-Hassan:

[2675] Ibid, p.369.
[2676] Ibid, p.370.
[2677] G. Wiet et al: *History;* op cit; p. 321.

> 'Technological subjects were an integral part of the philosophical sciences, and whilst the engineer (al-muhandis) enjoyed a high status in society, the artisan felt pride in being a member of a guild, where perfection in the craft was considered a form of worship.'[2678]

Finally, returning to the generalised assumption that the Renaissance and modern science and technology derive from Greece. Bedini, for instance, refers to the 'Arabs' (alongside Byzantium) but only as guardians and transmitters of Greek mechanical genius, until this genius burst to life in Renaissance Italy.[2679] He says, for instance,

> 'There appears to be no longer any question, on the basis of recent research, that the mechanical clock and fine instrumentation evolved in a direct line without substantial change from the mechanical water clocks of the Alexandrian civilisation, transmitted through Islam and Byzantine.'[2680]

There are many flaws in Bedini's argument. First and foremost, there is no such thing as something being dormant for centuries to suddenly re-emerge in the 16th century. This also contradicts the argument made by other Western 'scholars' (such as Lynn White) who have explained to us the same sudden emergence of technological genius, but at other times (12th-13th centuries), and in other places (of Western Christendom,) owing to Western Latin genius, not Greek genius. Secondly, if such authors as Ctesibius, Philon, and Heron, were available in Byzantium, why then did nothing appear for the ten centuries they were available there until the 'Renaissance'? Thirdly, if Byzantium was the source of the Western Renaissance, why then did such a renaissance not take place in Italy or other Western parts that were under direct Byzantine influence throughout all the Middle Ages? Italy was under direct Byzantine cultural influence for over ten centuries before the Renaissance, Constantinople becoming the New Rome in 330 CE, and at the end of Justinian's reign, in 565, the whole of Italy was part of the Byzantine Empire, and large parts of it remained under Byzantine rule for centuries. Fourthly, when Bedini holds that the mechanical clock and fine instruments evolved in a direct line without substantial change from the Alexandrian civilisation to the Renaissance, again, he is mistaken. He sets aside centuries of changes,

[2678] A.Y. AL-Hassan: Technology, *The Dictionary of the Middle Ages*, op cit; vol 11; pp 636-40.
[2679] S.A. Bedini: The Role of automata in the history of technology; in *Technology and Culture*, Vol 5; pp 24-42.
[2680] Ibid; p. 29.

ignoring the crucial role of Chinese and Islamic civilisations in the field (as abundantly demonstrated already). On fine technology, Hill also rightly notes that if any modern engineer 'might refer to Greek works, he could find most of his inspiration in the works of his Muslim predecessors. A similar process can be observed with other sciences and technologies.'[2681] Indeed, any engineer with interest in Islamic history can very easily come to the same conclusion that modern technology has little to compare with the Greek, but bears instead more resemblance with the Islamic. This can be easily proved by comparing devices in all three literatures: the Greek, the Islamic, and the modern. The clocks of the Renaissance, to which Bedini is referring, bear a fundamental difference with those of classical time. Finally, what were the fine instruments dating from the Alexandrian times Bedini is talking about? Most pre-Renaissance instruments either came to life, or acquired their perfected, modern form in the Middle Ages and not in Classical times.

Final Words on Transfers Between Islam and the Christian West:

A number of issues arise with respect to the matter of transmission of Islamic technological expertise how to the Christian West. Winder points out:

> 'On the basis of available scholarship we are forced to believe that al-Jazari's work, with the various pictures and diagrams that profusely illustrate it, did not transmit such important advances as conical valves to the European cultural revolution known as the Renaissance. If this transfer did not, in fact, take place, one must wonder why it did not, since al-Jazari's work appeared relatively early in medieval Islam, at a time when cultural transference from East to West was at its height. No compelling solution to the mystery suggests itself. Revived interest in Arab Islamic technology may, in time, produce one.'[2682]

Hill, for his part, notes that as research proceeds, firmer evidence for the transmission of Islamic fine technology into Europe can be provided.[2683]

[2681] D.R. Hill: Engineering, op cit, p. 786.
[2682] R.B. Winder: Al-Jazari; op cit; p. 188.
[2683] D. R. Hill: Engineering, op cit, p. 795.

He offers some lines of transmission, the most likely route being, as with much else, Spain, but also Sicily, Byzantium, and Syria during the Crusades.[2684]

Munro suggests the route through the court of Alfonso X the Wise (r. 1252-1284) at Seville.[2685] Alfonso commissioned the translation of a number of Islamic scientific treatises, including works on the design of astronomical instruments, which are contained in the *Libros del saber de astronomia and the Dos Iibros de las armellas,* and the treatise on machines by Al-Muradi *Kitab al-asrar fi nata'ij al-afkar* (Book of Secrets of the Results of Thoughts) was copied at Alfonso's court in Seville around 1266.[2686] Al-Muradi's treatise includes large machines with powerful prime movers to be found in subsequent European treatises.[2687] This manuscript is now in Florence at the Bibliotheca Laurenziana.[2688]

Oddly enough, this is precisely the route followed by a certain Brunetto Latini, a Florentine envoy, who also resided at Alfonso's court at the time, who was very much interested in the scholarly activities there, and who returned to his Florentine origins subsequently.[2689]

Besides, as Spain was conquered by Christian armies, the Muslims, masters of great skills then, were allowed to retain their functions and serve the new crown,[2690] so they may well have conveyed their skills to others.

The problem remains: how to piece all these matters together in a coherent line of transmission between 13th century Spain and Northern Italy, the cradle of modern Western technology.

It is fitting to conclude here by raising two final points.

First that the Eurocentric approach, jumping over nearly thirteen centuries, has not just failed to answer important issues, but has also set aside all matters that this chapter on technology and engineering has dealt with, and this chapter has only touched on the small and simple. In this respect, it is also worth noting with Hill, that the debt owed by Europe, in matters of technology, to Islam and other civilisations, has never been fully acknowledged.[2691]

[2684] D. R. Hill: Arabic Fine Technology, op cit, pp 41-2.
[2685] J.H. Munro: Treatises; op cit; p. 642.
[2686] Ibid.
[2687] Ibid.
[2688] D.R. Hill: *Islamic Science*; op cit, p 142.
[2689] F. Reichmann: *The Sources; op cit.* p.203.
[2690] N. Smith: *A History,* op cit, p .103.
[2691] D.R. Hill: *A History of Engineering*; op cit; p. 4.

Secondly, as Ludlow and Bahrani have pointed out, there are immense possibilities still awaiting in the thousands of Islamic manuscripts dormant in the European and North American libraries.[2692] Many answers lie in these manuscripts that could reveal how technology passed to the Christian West.

[2692] C.G. Ludlow and A.S. Bahrani: Mechanical, op cit, p. 79.

GEOGRAPHY

The interest given to Islamic geography and nautical sciences by a large number of authors mirrors its importance. Whether human geography,[2693] or nautical sciences,[2694] or other branches of the subject,[2695] there is ample information and a great choice of reference material. General syntheses by one single author have also been abundant; a good one is by De Vaux,[2696] and another is by Khratchokovsky.[2697] The latter is 919 pages long, covering the works of 260 Muslim geographers, and it includes a

[2693] See for instance:
-G. Ferrand: *Relations de Voyages et textes geographiques Arabes, Persans and Turks relatifs a l'Extreme orient du VIIem au XVIIIem Siecles* (Ernest Leroux, Paris, 1913-4.)
G. Ferrand: tr and ed: *Voyage du marchand Arabe Sulayman en Inde et en Chine* redige en 851… Paris; Edition Bossard; Vol vii; Les Classiques de l'Orient.
-A.Miquel: *La Geography Humaine du Monde Musulman*; 4 vols (Paris; 1967).
-C.de La Ronciere: *La Decouverte de l'Afrique au Moyen Age;* Vol 1; Published as Vol 5 of the memoires de la Societe Royale de Geography d'Egypte (Cairo; 1924).
[2694] L.Bagrow: *The Vasco de Gama's Pilot (*Genoa, 1951).
-G. Ferrand: *Instructions Nautiques et Routiers Arabes et Portugais des XV et XVI Siecles*, 3 Vols (Paris, 1921-)
-H. Grosset-Grange: La Science nautique Arabe, *Jeune Marine*, 1977-9, 16-29 (except 22).
—— *Glossaire nautique Arabe ancien et moderne de l'Ocean Indien* (Paris, 1993).
-G.F. Hourani: *Arab Seafaring in the Indian Ocean in Ancient and Early Medieval Times* (Princeton, 1971).
-G. Tibbetts: *Arab Navigation in the Indian Ocean Before the Coming of the Portuguese* (London. 1971).
[2695]A.F.L. Beeston: Idrisi's account of the British Isles; *Bulletin of the School of Oriental and African Studies*; 13 (1949), pp. 265-80.
A.Dallal: Al-Biruni on Climate in *Archives Internationales des Sciences;* 34; pp. 3-18.
J.B. Harley and D. Woodward ed: *History of Cartography in Prehistoric, Ancient and Medieval Europe, and the Mediterranean;* Chicago; 1987; Volume 2; Book 1: Cartography in the Traditional Islamic and South Asian Societies.
A. Jaubert: *La Geographie d'Idrisi* (Paris; 1836-40; Reprinted Amsterdam; 1975).
E.S. Kennedy: *A Commentary upon Biruni's Kitab tawhid al-Amakin; an 11th Century Treatise on Mathematical Geography* (Beirut; 1973).
E.S and M.H. Kennedy: *Geographical Coordinates of Localities from Islamic Sources* (Frankfurt; 1987).
O.J and A.M. Tuulio Tallgren: *Idrisi, la Finlande et les autres pays baltiques Orientaux;* Helsinki; 1930.
[2696] Barron Carra de Vaux: *Les Penseurs de l'Islam*, op cit; vol ii; chaps 1-3; pp 1-100.
[2697] I.J. Krckovskij: *Izbrannye Socinenja* (chosen works); Vol 4 (Moscow, 1957).

bibliography of 54 pages, a work so thorough that it took its author forty years to complete 'A work of a lifetime gifted to us,' says M. Canard in his review of it.[2698]

However, the abundance of works does not mean the matter is as adequately dealt with as one would wish. As usual, some crucial issues have remained obscured such as, for instance, the impact of Islamic nautical science on subsequent 15th–16th century discoveries. Another flaw is the constant attribution of Islamic geographical achievements to Greek predecessors even if such Greek influence limited itself to Ptolemy's writing, focusing on place locations, with little or no contribution to other branches of the subject such as human geography or nautical science; this narrow focus is wrongly widened to generalised influence on Muslim geography.

The other problem is the tendency amongst many to inflate the works of the 10th century geographer al-Mas'udi (912-957) and set aside the rest.[2699] Al-Mas'udi's *Muruj al-Dhahab wa Ma'adin al-Jawhar* (Meadows of Gold and Mines of Gems) at best can compare to the works of the likes of al-Idrisi, al-Biruni, Yaqut, and al-Muqaddasi.[2700] Other geographers accomplished much more. Al-Biruni (973-1050), for instance, wrote the best material on the subject; his accomplishments, as briefly outlined here, included creating the branch of mathematical geography, determining with remarkable precision the coordinates of a number of places, introducing a simplified method of stereographic projection, describing India, explaining the occurrence of natural springs and of artificial wells by laws of hydrostatics, reflections on the Indus valley, such as that it was probably an ancient sea-basin which had gradually filed up with alluviums,[2701] and scientific comments on the distribution of land and water on the face of the globe.[2702]

Many authors dealing with Islamic geography, such as Ronan, also hold that Muslim geography declined after al-Masudi's death, which is incorrect. A brief look at any source shows that Muslim geography, in

[2698] In *Arabica*, Vol 5 (1958, Leiden), pp. 197-200.
[2699] Such as C. Ronan: The Arabian, op cit, pp 229-33.
[2700] Al-Muqaddasi, according to Sprenger, is the greatest geographer ever. Cited by Kramers, 'La literature geographique classique des Musulmans', *Analecta Orientalia*, i (Leiden, 1954), p.181, in D.M. Dunlop: *Arab Civilisation,* op cit, at p. 165.
[2701] G. Sarton: *Introduction*; Vol 1; op cit; p.699.
[2702] In the printed version of *Kitab al-tafhim*, edited and translated by R. R. Wright: *The Book of Instruction in the Elements of the Art of Astrology* (London; Luzac; 1934), pp. 120-4. The map that accompanies it on p. 124 shows for the first time this new conception of the world. In G.R. Tibbetts: Later Cartographic Developments; in *History of Cartography;(* J.B. Harley and D. Woodward ed;) op cit; pp. 137-55; p.141.

fact, peaked following al-Masudi's death. Ronan, like Renan, also blames the decline of both Muslim geography and society on the 'heavy hand of Islam' in the 13th century[2703] (an issue to be considered in the final part of this work), whilst ignoring that the Muslim land in the 13th century was devastated by invasions (crusades, Mongols, the loss of Muslim Spain, etc,) which destroyed scholarship, and killed geographical inquiry. One geographer, Yaqut, for instance, in the wake of the bloody Mongol devastation of eastern Islam in 1220 had to flee the city of Merw, where he was working on his geographical encyclopaedia, with nothing but the clothes he was wearing, clutching his manuscripts, running across Persia to Mosul.[2704]

Another problem relates to some modern studies of Muslim science and civilisation, which are very poor compared to those that preceded them up to a century; the article by Grosset Grange and H. Rouquette on Islamic nautical science in Rashed's encyclopaedia of Arabic science,[2705] for instance, is of very poor quality compared to works such as by Ferrand which are nearly a century older.[2706]

Another problem relates to the contradictory nature of writing, which one finds in the same author, censuring and praising Islamic science at once. Hence, Tolmacheva, for instance, says:

> 'It is thus obvious that while Islamic geography faithfully preserved ancient and foreign geographical concepts, it failed to produce its own form or to develop a viable synthesis of the old forms with the-new information. Its chief value, then, is not in the field of theory, but in the facts it accumulated, particularly because the total volume of preserved data is very considerable. Its significance goes beyond geography into other areas of knowledge, at least in part because of the prevalence of descriptive geography... and it was also customary to discuss other sciences in the introductions to geographical works. For some parts of the world, or certain periods of their history, medieval Islamic geographers provide major, if not the only, sources of information. Their works are thus invaluable and often indispensable to the study of history and historical ethnography, as well as historical geography and the history of science.'[2707]

[2703] C. Ronan: The Arabian; op cit; p. 230.
[2704] W. Durant: *The Age of Faith;* op cit; p. 329.
[2705] H. Grosset Grange (in collaboration with Henri Rouquette): Arabic Nautical Science, in *Encyclopaedia* (Rashed ed); op cit; pp 202-42.
[2706] G. Ferrand: *Relations de Voyages et textes*; op cit.
[2707] M.A. Tolmacheva: Geography and cartography: Islamic; *Dictionary of the Middle Ages*; Vol 5; pp 391-5; at p. 394.

From what has just preceded, it becomes, thus, necessary to approach the subject from a more searching perspective.

1. Muslim Geography: Foundations:

Exploring Muslim geography, once more, raises the matter of what factors were behind the sudden drive for geographical knowledge in early Islam; amongst such factors, the role of the faith comes to the fore again as the main and crucial factor. Islam urged people to open their horizons and know about the wonders of God's creation, which acted as a fundamental stimulus for geographical curiosity. Journeys were also undertaken to build the records of the Prophet's sayings (Hadith) or for the purposes of administration and trade, or simply to satisfy curiosity, to say nothing of pilgrimage.[2708] Hence, roughly, the same combinations of observance of the faith and practical necessities that account for the rise of other sciences and aspects of Islamic civilisation. These central elements are considered in succession, beginning with the direct role of the faith.

a. The Islamic Faith and the Rise of Islamic Geography:

The rise of Islamic geography does not owe anything to Greece, or Ptolemy, but like other sciences and aspects of civilisation to Islam, owes nearly everything to the faith. A number of factors related to the observance of the faith account for it.

Islam, first and foremost, regarded a journey to perform the pilgrimage rites at Makkah as a duty incumbent upon every capable Muslim at least once in a lifetime.[2709] And, thus, whilst nearly all early Muslim geographers included itineraries to Makkah, or placed it at the centre of their maps (as will be elaborated upon further on), later geographers used the same pilgrimage, that on particular occasions, lasted over a decade,

[2708] G.H. T. Kimble: *Geography in the Middle Ages* (Methuen &Co Ltd; London; 1938), pp. 48-9.
[2709] R. Bulliet: Travel and Transport; *Dictionary of the Middle Ages;* op cit; vol 12; pp. 147-8; p. 147.

and even twenty five years,[2710] to write most elaborate travel and geographical narratives and treatises. One amongst such pilgrim-scholars was Mohammed al-Andalusi (b. in Ceuta in 1259), who left for pilgrimage, passing through North Africa, to Egypt, then Syria, and who not only wrote on Tradition, but also left two travelogues carrying the appropriate title of *rahalat* (travels), where he describes his routes, men of letters, natural history, etc.[2711] More famed, is the traveller Al-Tidjani, who in the year 1309, left Tunis to perform his pilgrimage, and who wrote on his *Rihla*.[2712] In this travel, he observed everything he could, providing information not just about the places he visited, but also about neighbouring territories, providing geographical and historical information of the first order, which was vastly used by subsequent writers, whether Ibn Khaldun, or Amari, the latter in his history of Muslim Sicily, relying heavily on accounts of al-Tidjani about the island.[2713] The great al-Maqrizi (d. 1442), equally, used the occasion of his pilgrimage to spend four years in the Hijaz, studying the routes followed by the pilgrims from southern Arabia and Abyssinia, and revising the geographical dictionary of al-Himyari, and that was years before he wrote his famed *Khitat* (in 1439), which remains one of the best works on medieval Egypt.[2714] Pilgrimage could also be combined with study and trade, two further powerful elements in geographical knowledge. Bulliet notes how trade and pilgrimage could be combined without religious objection, and several years might be spent making the pilgrimage to Makkah from some distant location.[2715]

Another travel objective was the search for religious knowledge, particularly in the form of traditional lore (Hadith). Indeed, some of the sayings of the Prophet explicitly enjoined such travels in quest of knowledge, but more important as an inspiration was the educational stricture, which prevailed through the 11th century, that valid learning was

[2710] Ibn Jubayr, for instance, wrote his narratives of travel on the pilgrimage to Makkah, which he undertook to expiate a sin (drinking wine). Ibn Jubayr: *Voyages*, tr. with notes by M. Gaudefroy Demombynes (Paris, 1949-65).
Ibn Battuta also left his hometown of Tangiers with the intention of pilgrimage to Makkah, which he accomplished five times, and all the adventures in between, he relates in his work. Ibn Battuta: *Travels in Asia and Africa;* trans and selected by H.A.R. Gibb; Routledge; London, 1929.
[2711] I.J. Krckovskij: *Izbrannye Socinenja;*. Pp. 382-3.
[2712] H. H. Abd-al-Wahab: *Rihlat al-Tijani;* Tunis; 1959.
[2713] I.J. Krckovskij: *Izbrannye Socinenja;*. Pp. 383-4.
[2714] Ibid. pp. 525-6.
[2715] R. Bulliet: Travel and Transport; op cit; p. 147.

dependent upon direct oral transmission.[2716] This requirement of an unbroken chain of oral transmission (*isnad)* going back to the Prophet, regarded as the best possible guarantee of authenticity in this vital area of religious knowledge, made it necessary for the industrious scholar to spend months or years travelling from city to city to collect additional lore.[2717] This developed into a tradition whereby virtually every scholar of significance travelled extensively at some point in his life[2718] and of course wrote on such travels. Remarkably, this tradition lasted much beyond the early centuries of Islam. Al-Samani (1113-1167), for instance, was a 12th century exegesist and a traditionist, who became well known as a historian, completing the history of Baghdad and also writing on the history of his native place, Merw.[2719] He performed many travels in search of knowledge, visiting Central Asia, Iraq, Syria, Jerusalem, and the Arab Peninsula, writing in the process *Kitab al-Ansab* (the Book of Genealogies), which is both on history, but also on geography, focusing on the origins of names he was citing, hence, encompassing a vast geographical scope. [2720] Writing on the genealogy of al-Sin, for instance, drove Al-Samani to list a good number of people who bore that epithet, and who visited China for trade or other purposes, allowing him to throw light on issues relating China, the Maghrib, Central Asia, and so on.[2721] This work had a wide impact, and was used as a source by subsequent geographers and historians such as Yaqut al-Hamawi and Ibn al-Athir.[2722]

The compilation of the Prophet's sayings also influenced Islamic geography considerably by imposing the strictest compliance with accuracy and precision. Kimble thus points out, that it is not surprising to find Muslim scholars, with all their consideration for the feelings and traditions of the past, submitting their authorities to severe critical analysis and revising them where expedient.[2723] Al-Khwarizmi (d. 835), for instance, substantially improved Ptolemy's geography in his Face of the Earth, as regards both text and maps.[2724]

[2716] Ibid.
[2717] Ibid.
[2718] Ibid.
[2719] I.J. Krckovskij: *Izbrannye Socinenja.* op cit; pp. 319-20.
[2720] I.J. Krckovskij: *Izbrannye Socinenja;* 319-20. See also S.M. Ahmad: *History*; op cit; p. 179.
[2721] I.J. Krckovskij: *Izbrannye Socinenja;* 319-20.
[2722] I.J. Krckovskij: *Izbrannye Socinenja;* 319-20. See also S.M. Ahmad: *History*; p. 179.
[2723] G.H. T. Kimble: *Geography*; op cit; pp. 48-9.
[2724] This work was accompanied by a map of the world executed by al-Khwarizmi and sixty nine other scholars at the instigation of Al-Mamun; in G.T. Kimble: *Geography*; Note 1; p. 49.

Staying with religious necessity, Sayili notes how mathematical or astronomical geography was a very important field of application for astronomy, and religious needs supplied a strong motivation for work in this field.[2725] Al-Biruni thus speaks of the need for the knowledge of geographical locations in determining the direction of Makkah which every Muslim has to face during the prayers, and he also insists on other benefits. He says:

> 'I believe that this benefit is not limited to this aspect only of our divine services but that it extends to other things. For whosoever determines the longitude and latitude of his country with precision will thereby be enabled to find out the exact time of noon and afternoon, and of the end of evening twilight and of dawn, times which are needed not only in connection with the prayers but also for fasting, and likewise, he will thereby be in a position to ascertain the times of the new moon, although the religious law restricts the determination of this latter to direct observation because of the Tradition in which the Prophet (God Blessing be upon him) said: 'We are people who do not write and do not calculate; adding: 'we indicate the month thus and thus and thus,' showing the ten fingers three times, 'then thus and thus and thus,' folding the thumb at the third time.[2726] Moreover the usefulness here exceeds religious matters and extends to worldly affairs, and what has been mentioned is also beneficial in finding the correct direction towards one's destination and is therefore desirable in that it will bring good and prevent harm.'[2727]

b. Practical Necessities:

The second element in the rise of Islamic geography, like other sciences, was practical necessity. Ibn Rusta (fl 903) wrote *Kitab al-A'laq al-Nafisa*, the introductory pages of which are devoted to a detailed discussion of the most essential fundamental astronomical notions for the solution of geographical problems such as the size and shape of the earth and the location of places.[2728] This is followed by the study of geography of

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[2725] A. Sayili: *The Observatory*; op cit; p. 24.
[2726] See Bukhari: Sahih; Book 30 (on fasting) section 13. and Muslim: Sahih; Book 13; tradition 15.
[2727] Al-Biruni: *Tahdid al-Amaqin*; op cit; pp. 323-4.
[2728] Ibn Rusta: *Kitab al-A'laq al-nafisa*; ed De Goeje (Leyden; 1892), vol vii.

Persia, and the adjoining lands, Khurasan, and the roads leading to Ispahan, Baghdad, Kufa, besides giving the distances between the stations, and the nature of the countries.[2729] Ibn Khurdadhbih (Khurradadhbih and other spellings) (d.912) wrote 'book of roads and provinces' (*Kitab al-massalik wal-mamlik*).[2730] Ibn Khurradadhbih was a postal official, and so his interest in the postal routes was purely professional.[2731] His work provides important facts on the historical topography of the caliphate, giving a full map and description of the main trade routes of the Muslim world.[2732] His routes are easy to follow giving the distances between places in parasangs (about four miles).[2733] Many other works from other authors bore the same title (*Massalik/routes*) giving the names of towns and countries, distances between them, their people, rulers, tax systems, topography of the land, and crucially, their water resources.[2734] Although these books focused on the Islamic world, most early writers also extended their interest to India, China, the Indian Ocean, and as much of Europe as they could.[2735] Amongst such authors are Al-Jayhani and al-Marwazi, whose works have been lost.[2736] Extracts from Al-Jayhani's (fl 903) can, however, be found in Al-Muqaddasi who informs us that Al-Jayhani indicates the resources of the countries, the routes and distances, and accounts of the plains, valleys, hills, mountains woods and rivers, which are found in them.[2737] Qudama's *Kitab al-Kharaj* (Book of the Land Tax) written early in the 10th century, also covers postal routes of the Muslim land, stages and distances, revenues for each province, general remarks on seas and mountains, etc.[2738]

One of the most elaborate of these works is Al-Muqaddasi's (d.1000) *Ahsan al-Taqasim,* the first to produce maps in natural colours.[2739] *Ahsan at-Taqasim,* completed around 985, after preliminary chapters on general

[2729] Ibid.
[2730] Texts and translations: First edition with French translation and notes by C. Barbier de Meynard: le Livre des routes et des provinces; *Journal Asiatique*, vol 5, 1-127, 227-95, 446-532, (1865). A better text has been published by M.J. de Goeje, with French translation and notes: *Bibliotheca geographorum arabicorum*, 6 (Leyden; 1889).
[2731] G.R. Tibbetts: The Balkhi School of Geographers in *History of Cartography* (Harley-Woodward ed); op cit; pp. 108-29; at pp. 117.
[2732] Al-Ya'qubi: *Les pays*, tr. G. Wiet (Cairo, 1937).
[2733] G.R. Tibbetts: The Balkhi School of Geographers; op cit; p. 117.
[2734] Carra de Vaux: *Les Penseurs,* op cit, p. 3.
[2735] G.R. Tibbetts: The Balkhi School of Geographers; op cit; pp. 116-7.
[2736] Ibid; p. 117.
[2737] Al-Muqaddasi: *Ahsan at-taqasim fi Ma'rifat al-Aqalim*; M.J. de Goeje ed., Bibliotheca Geographorum Arabicum, 2nd edition., III vols (Leiden, 1906); vol 3; p.4.
[2738] C. de Vaux: *Les Penseurs*; op cit, pp 27-8.
[2739] Al-Muqaddasi: *Ahsan at-taqasim;* op cit.

geographical ideas, gives the geographical arrangement of its different parts of the Islamic world, and an approximate estimate of the distance from one frontier to the other.[2740] The countries that are included are Arabia, Iraq and Mesopotamia, Syria, Egypt, and the Maghrib (North Africa), Spain, into Transoxiana (W. Turkestan), Khurasan, North-West Iran (Azerbaijan, Armenia Transcaucasia), Jibal, Khuzistan (the South-West, ancient Elam or Susiana), Fars (Persia), Kirman and finally Sind (the valley of the Indus).[2741] Each chapter is generally divided into two parts, the first of which enumerates the different localities and gives good topographical descriptions, especially of the principal towns, whilst the second part lists all sorts of subjects which the author groups under the label of 'particular characteristics.[2742] It looks at towns, their people, the social and ethnic groups, commerce, natural resources, archaeological monuments, currencies, the political situation, a vast array of subjects, which Al-Muqaddasi himself, defines:

> 'I thought it expedient to single out the chorography of the land of Islam, comprising a description of deserts and seas, lakes and rivers, famous cities, resting places and the high ways of commerce, its exports and the staple commodities; an account of the inhabitants of different countries; of the diversity of languages and manners of speech; of their dialects and complexion, their religious tenets; of their measures and weight, their coins both large and small; with particulars of their food and drink, their fruits and waters.. the salt lands, the rocky wastes and sandy deserts, hills, plains and mountains, the limestone and sandstone; the fat and lean soil, the lands of plenty and fertility... the industrial arts and literary avocations.'[2743]

There is, thus, no subject of interest to modern geography, Kramers says, which is not treated by al-Muqaddasi; Miquel, for his part, praises him as the creator of 'total geographical science.'[2744]

Devising maps of regions and countries, as will be amply explored further on, also arose out of practical necessity. Bagrow notes how itineraries and route maps had to be compiled for various purposes such as diplomatic missions into distant lands, such as to China in 704-715, and Kashgar in 684; for military campaigns such as for the advance into Asia Minor and

[2740] D.M. Dunlop: *Arab Civilisation 800-1500 A.D* (Longman Group Ltd, 1971), p. 166.
[2741] Ibid.
[2742] Ibid.
[2743] Al-Muqaddasi: Ahsan al-Taqasim; op cit; pp. 1-2.
[2744] In D.M. Dunlop: *Arab Civilisation;* op cit; p. 166.

the Oxus from 684; and for various trading expeditions by land and sea.[2745]

Also contributing to geographical knowledge was the vast extent of the land of Islam, unhindered by frontiers, thus encouraging movement. Hence Al-Biruni observes:

> 'Islam has already penetrated from the eastern countries of the earth to the Western. It spreads westwards to Spain (Andalus), eastward to the borderland of China and to the middle of India, southward to Abyssinia and the countries of Zanj (Africa, the Malay Archipelago and Java), northward to the countries of the Turks and Slavs. Thus the different people are brought together in mutual understanding, which only God's own Art can bring to pass.....'[2746]

Bulliet notes how Islamic society was a place where long distance travel was common, an impression supported by the rarity of historical evidence of political barriers to travel, even between hostile states, or by efforts of governments to control the movements of their subjects.[2747] The measure of a prosperous and strong Islamic state, then, was that the routes were so secure that travellers could move wherever they wished without molestation.[2748]

c. Trade:

Long-distance trade was well established from the very beginning of Islam, and was encouraged by religious attitudes developed within the strongly commercial environment of Makkah.[2749] Trade with, and in direction of, China, was the one main factor that stimulated Islamic geographical and nautical knowledge, Muslims producing very likely the earliest written accounts of that country. Descriptions of China date from the early 9th century through the work of a merchant: Suleiman (first half

[2745] L. Bagrow: *History of Cartography*; Revised and Enlarged by R.A. Skelton (C. Watts and Co Ltd; London; 1964), p. 54.
[2746] In *The Book of the Demarkation of the Limits of the Areas* In N. Ahmad, *Muslim Contribution to Geography* (Lahore: M. Ashraf, 1947), p 35.
[2747] R. Bulliet: Travel and Transport, op cit; pp. 147-8.
[2748] Ibid.
[2749] Ibid; p. 147.

of the 9th century), whose accounts are taken up by Abu Zeid Hassan.[2750] Abu Zeid (d.976) from Siraf in the Arab Gulf, seeks to complete Suleiman's accounts, and also refers to one Ibn Wahab, who visited the Chinese court in 870.[2751] Abu Zeid is the author of the second part of *Silsilat al-Tawarikh* (The Chain of Histories).[2752] He says that his main duty is to examine the work of Suleiman and to complete his narrative using all he had collected in his own studies and gained from the experiences of others.[2753] He also makes the point that he does not reproduce untrue accounts and 'sailor stories', and that it is better to relate truth however much shorter it is.[2754] Abu Zeid tells us of a great revolution in China, of the Chinese manners and customs, dress, and other peculiarities as well as the inter-connectedness of seas.[2755] He speaks of boats sailing for China depart from Basra and Siraf, and that they bring cargo from Siraf and Oman on boats, before loading it on to ships sailing for China because coastal waters were too shallow.[2756] Fresh water was also loaded at Siraf and Muscat, from where ships sailed to Oman, and from there to India; then the island of Sander Faulat (Singapore); Jinji (Chinji), before anchoring near the gate of China. Ships passed between the hills of the Straits of China, entered the Chinese Gulf, and dropped anchor in Khanfua (Khanpua).[2757] Through Suleiman, we are informed that 'the sea between India, China and Ceylon abounds in large fish, and when the ships sail at night, the bells ring to keep them away.'[2758] The most frequented Chinese port was Khanfu, now Canton, where Muslim traders had their own establishments, and where soon an important Muslim colony was to grow.[2759] From Khanfu some Muslim traders travelled as far as the empire's capital, Khomda; a two month journey.[2760] China, according to Muslim merchants, was a safe, well administered country; and its laws applying to travellers yielded both safety and good order.[2761] We are also informed by Suleiman that China produce wheat,

[2750] *Relations des Voyages faites par les Arabes et les Persans dans l'Inde et a la Chine*, ed. et tr. Langles et Reinaud, 2 vols (Imprimerie Royale; Paris; 1845).
[2751] G. Sarton: *Introduction*; op cit; vol 1; p.636.
[2752] Edited by Reinaud (Paris; 1845).
[2753] S.M.Z. Alavi: *Arab Geography* (The Department of Geography; Aligarh; 1965), p. 33.
[2754] In Carra de Vaux: *Les Penseurs de l'Islam*; op cit; pp. 53-9.
[2755] S.M.Z. Alavi: *Arab Geography;* op cit; p. 33.
[2756] A.S.S. Nadvi: *Arab Navigation* (S. M. Ashraf Publishers; Lahore; 1966), pp. 55-8.
[2757] Ibid.
[2758] Ibid; p. 52.
[2759] J.H. Kramers: Geography and Commerce, in *The Legacy of Islam* (edited by T. Arnold and A. Guillaume,) op cit; pp 79-107; at p. 95.
[2760] Carra de Vaux: *Les Penseurs*; op cit; at pp. 55-6.
[2761] Ibid, p. 58.

rice, and many other grains, as well as apples, pears, citrons, quinces, bananas, sugarcane, etc.[2762] He also mentions a Chinese herb, called al-Shah from which the Chinese prepare a drink by pouring water on the leaf of this plant.[2763] Suleiman also observes that the coast of China is subject to violent rainstorms, which make shipping conditions dreadful on the Chinese Sea.[2764]

Trade with China also stimulated and fed the knowledge of geography by a good number of Muslim geographers, who described China from the 9th century, and for centuries onward. Ibn Wahab, a contemporary geographer, tells of his encounters with the Chinese emperor, and describes the Chinese capital, which he says, had two halves, separated by a wide road.[2765] Al-Yaqubi (fl. 875 or 880) wrote *Kitab al-buldan* (Book of the Countries),[2766] probably the first work in Arabic on historical geography, describing almost the whole Islamic world, and also the Byzantine Empire, India, and China.[2767] Historical details, statistics, and topographical observations abound in this work, in which the author makes use of the materials he has collected during his travels.[2768] He says on China that it is an immense country that can be reached by crossing seven seas; each of these with its own colour, wind, fish, and breeze which could not be found in another, the seventh, the Sea of Cankhay, only sailable by southern winds.[2769] Not long after Al-Yaqubi, Ibn al-Fakih completed, c. 903, a 'Book of the Countries" (*Kitab al-Buldan)*,[2770] which draws very interesting comparisons between China and India, their customs, food diets, codes of dress, rituals, and also flora and fauna. In the same year, Ibn Rusta (903) compiled an encyclopaedia called "The Very Precious Things, or "The Precious Bags of Travelling Provisions" (*al-atlaq al-nafisa*) of which the geographical portion is extant.[2771] It contains

[2762] Sulaiman: *Silsilat al-Tawarikh;* Ed Reinaud (Paris; 1845), p.24.
[2763] Ibid; p. 41.
[2764] Ibid; pp. 11-2.
[2765] Carra de Vaux: *Les Penseurs;* op cit; pp. 57-8.
[2766] The *Kitab al-buldan* appears in M. J. de Goeje, ed., *Bibliotheca ceocraphorum arabicorum,* Vll (1892); Ed and tr into French by G Wiet: *Les Pays* (1937).
[2767] L.I. Conrad: Al-Yaqubi; *Dictionary of the Middle Ages;* op cit; vol 12; pp. 717-8; at p. 718.
[2768] Ibid.
[2769] G. Ferrand: *Relations de Voyages et textes geographiques Arabes, Persans and Turks relatifs a l'Extreme orient du VIIem au XVIIIem Siecles*; E. Leroux, Paris, 1913-4. Extracts above are from the re-edition by F. Sezgin of Ferrand's work (Frankfurt, 1986), p.49.
[2770] *Kitab al-boldan* auctore Ibn al-Faqih al-Hamadhani; edited by M. J. De Goeje; Bibliotheca geographorum arabicorum, 5 (Leiden, 1885).
[2771] G. Sarton: *Introduction*; op cit; vol 1; p.635.

an introduction dealing with the celestial and terrestrial spheres, then proceeds to describe the countries, focusing on Khmer society, its ruler, and the local legal system.[2772] Abu'l Faraj (988) dwells on India, its people, customs, and religions, but also devotes much attention to China, saying it has 300 cities, all with considerable numbers of people.[2773] Whoever travels in China, he notes, registers his name, the date of his journey, his genealogy, his description, age, and what he carries with himself, a register, which is kept until the journey is safely completed, the reason for this being to avoid bringing shame on the ruler should anything happen to the traveller.[2774] Qazwini (d.1283) gives accounts of the creatures that thrive in the Sea of China, whales, turtles, and monstrous snakes landing on the shores and eating entire buffalos and elephants.[2775]

There is a very interesting, little known, work by Jitsizo Kuwabara, dating from 1935, which deals with the Muslim links with China, but from the Chinese side.[2776] The gist of the work was first published in Japanese in 1915 to 1918 in the Shigaku zasshi, and the revised and enlarged English version appeared in the *Memoirs* of the Research Department of the Tokyo Bunko, nos 2 (1928) and 7 (1935). The present volume published posthumously, incorporates all the notes and corrections made by Dr Kuwabara in his life time.[2777] Kuwabara gives a good history of the Arabs in China during the T'ang and Sung dynasties.[2778] It is from the 8th century to the end of the 15th century that the Arabs travelled to China from the Persian Gulf, crossing the Indian Ocean, and passing through the Malay Peninsula, coming to Canton, where they carried trade. The Arab traders at the open ports of China lived in a settlement assigned by the Chinese government, but sometimes they lived in the city with the Chinese. Anxious to promote foreign trade, the government was lenient and the Arabs enjoyed virtually the rights of extraterritoriality. During the Sung and Yuan eras, they bought many ships built in China. The Arab traders usually took two years to make a voyage to China and back home. They

[2772] G. Ferrand: *Relations de Voyages; op cit; pp. 54-66.*.
[2773] Ibid; p.118 ff.
[2774] *Ibid;* p.130 ff.
[2775] Ibid; pp 302-4.
[2776] Jitsizo Kuwabara: *To so jidai ni okeru Arab-jin no Shina Tsuho no gaiko; kotomi So matsu no Teikyo-shihaku Saiiki-jin Ho Ju-ko no jiseki* (Piu Shou-Keng, a man of the Western regions, who was superintendent of the Trading Ships' office in Chiuan-chou towards the end of the Sung dynasty, together with a general sketch of trade of the Arabs in China during the T'Ang and Sung eras) Tokyo; Iwanami; 1935. Reviewed by Shio Sakanishi; *ISIS*; vol XXX; pp. 120-1.
[2777] Ibid; P. 121.
[2778] Ibid.

arrived with the south west wind of spring and summer and left with the north-east wind of October and December.[2779]
These trading contacts had dramatic consequences socially, and also scientifically. On the first front, the Surname of P'u. P'u is a transliteration of Abu (Abou), a common Arab name; the Sung Shih records that in the San fo-ch'I country, a large proportion of the people are surnamed P'u.[2780] Arab traders brought their wives with them, but a few traders married Chinese women. A record shows that an Arab marrying a Chinese lady of the imperial family was promoted to high official position.[2781] Some of the Arabs also studied Chinese culture and language. The impact on the sciences and the development of navigation was equally dramatic. The Chinese knew comparatively early the polarity of the magnetic needle, but it was the Arabs who applied it to navigation, and the mariner's compass was brought back to China.[2782]

Trade was also a fundamental factor behind Islamic writing on Korea, and a good number of Muslim geographers wrote on Korea between the 9th and 15th century, and were studied by Kei Won Chung and Hourani.[2783] The Muslims used the name al-Shila or al-Sila, after an early dynasty which ruled there until 935 to refer to Korea.[2784] Their reports begin in the middle of the 9th century with accounts by the same Suleiman the merchant and Ibn Khurdadhbih, followed by others such as Al-Masu'di, Qazwini and al-Makrizi.[2785] Interestingly, the presence of Muslims in Korea is also accounted for in Korean histories of Muslim merchants and their associates in the 10th century.[2786] There is reference to a Muslim, a certain Minabo (Munabbi?) who became mayor of Pyong Yang in the early 11th century,[2787] and of Muslim settlements in a town, where they wore their own type of clothing and head gear, and where they kept their religion, built a mosque and observed Muslim festivals.[2788]

[2779] Ibid; p. 120.
[2780] Ibid.
[2781] Ibid; p. 120.
[2782] Ibid.
[2783] Kei Won Chung; G.F. Hourani: Arab Geographers of Korea; *Journal of the American Oriental Society*; vol 58; pp. 658-61.
[2784] Ibid; 658.
[2785] Ibid; 658-60.
[2786] Chosen Yuska; Seoul; 1932; no 3; vol 1; p. 222. in Kei Won Chung; G.F. Hourani: Arab geographers p. 661.
[2787] Ibid.
[2788] Yi Neung Wha: *History of Korean Buddhism* (Seoul; 1917), Vol 2; p. 605.

d. Diplomacy and Politics:

Diplomacy and politics, finally, also stimulated geographical knowledge, a well known instance being that of Ibn Fadlan's travels to Scandinavia, as mentioned below. Earlier than that, according to Ibn Dihya (d. 1235) a visit took place by al-Ghazal (d. 860) to the land of al-Madjus (Scandinavia) for the same purposes, which constitutes one of the earliest documented contacts with Scandinavia.[2789] It was in the year 845 that the ruler of Muslim Andalusia, Abd Errahman II (ruled 822-852), established contacts with the Vikings of Ireland, through his envoy, Al-Ghazal. The first Viking attack on the Emirate of Cordova dates from 844, a Norwegian adventure, undertaken by way of the Biscay Coast from original bases in Ireland. According to Allen, the Vikings expressed strong trading interests: in their case, 'trade followed the sword.'[2790] To them Andalusia was a marvel of attraction as the richest and most famous part of Western Europe, whilst for the Muslims, through exchanges with the Vikings, Andalusian merchants could penetrate the markets of Northern Europe.[2791] The Muslims were also at war with Charles the Bald and the Franks, and so they sought alliance with the Vikings who themselves were also in conflict with the Franks.[2792] A vast geographical literature ensued following these contacts with Scandinavia, Muslim accounts remaining the earliest and most thorough of that region for the medieval period.[2793]

In the year 965, two embassies were sent by Muslim rulers of North Africa and Muslim Spain to the German Emperor Court in Magdeburg. The German emperor listened to the two embassies, who themselves listened to the emperor about central Europe, and on their return, each of these embassies recorded their impressions.[2794] Their accounts contain valuable information on the Kingdom of the Slavs in central Europe during that period, details on the coastal towns of France, Holland, and

[2789] W.E.D. Allen: The Poet and the Spae-wife: An Attempt to Reconstruct Al-Ghazal's Embassy to the Vikings (1960), in *Viking Society for Northern Research*, Saga-Book, 15 (1960).
[2790] W.E.D. Allen: The Poet and the Spae-wife: pp. 1-14. See also S.M. Ahmad: *A History*; op cit; p.39.
[2791] Ibid.
[2792] Ibid.
[2793] See Harris Birkeland: *Nordens hidstorie I middelalderen etter arabiskenkilder*, Norske Videnskaps-Akademi i Oslo, Skrifter, Hist.-Filos. Klasse, 2 Scriffer, 1954, 2 (1954).
[2794] I.J. Krckovskij: *Izbrannye Socinenja,*. Op cit; pp. 190-2; S.M. Ahmad: *History*; op cit; p. 116.

Germany. Such accounts are mainly found in the work of Yaqub al-Israili as preserved in the works of the later cosmographers such as Al-Qazwini and Abu'l Fida.[2795]

In the far eastern parts of Islam, Abu Dulaf (born in Yambo, near Makkah) (fl early 10th century) spent his career in Bukhara at the court of the Samanid prince Nasr ibn Ahmad ibn Ismail, who ruled from 913 to 942.[2796] Poet and traveller, Abu Dulaf returned to southern India across Tibet with the embassy of the Hindu prince, Kalatli ibn Shakhbar, and came back by way of Kashmir, Afghanistan, and Seistan.[2797] He wrote a narrative of his journeys called *'Aja'ib al-Buldan*, (Marvels of the Countries/Wonders of the World) extracts from which have been preserved by Yaqut al-Hamawi.[2798]

Al-Biruni, who spent much of his working life in the court of the Sultan Mahmud of Ghazna (11th century), accompanied him in his expedition to India in the year 1000, and en route wrote his observations of the province of Sindh, and northern India, and through his own calculations corrected the maps of the region.[2799]

2. The Vast Scope of Islamic Geography:

Muslim geographers dealt with a vast variety of subjects, and covered nearly all of the known world of their time. It is impossible to give justice to all works and authors, and all that can be attempted here is the sort of outline that shows as much as possible, whilst trying to cover the vast scope of subjects covered by Muslim geographers. Focus, first is on the geographers of eastern Islam.

Amongst the earliest works from the East is *Kitab al-Sifat* By Nadjar B. Sumaiyil (b. 740), some chapters of which are devoted to the sun and the

[2795] I.J. Krckovskij: *Izbrannye Socinenja,*. Op cit; pp. 190-2; S.M. Ahmad: *History;* op cit; p. 116.
[2796] G. Sarton: *Introduction*; op cit; vol 1; p. 637.
[2797] Ibid.
[2798] Ibid.
[2799] G. Le Bon: *La Civilisation*; op cit; p.370.

moon, wells and the seas, winds, snow, and rain.[2800] Al-Jahiz (ca. 776-868) wrote *Ajaib al-Buldan* (the Wonders of the World), which discusses amongst other things the important cities of the Islamic world; his other work, *Kitab al-Hayawan* (The Book of Animals) deals amongst other things with adaptation to environment.[2801] Al-Kindi (813-870) wrote on tides, as well as on the shape and size of earth, whilst his works on meteorology and geology deal with physical geography, and his works on medicine supply information on the distribution of plants and animals.[2802] Ibn Khurdadhbih's *al-Masalik* includes much information on Korea, Japan, and the Southern Asiatic coast as far as Brahmaputra, the Andaman Islands, Malaya and Java.[2803] Ibn Serapion, who wrote a geographical account of the world, describes great rivers such as The Euphrates, The Tigris and The Nile, and explains the system of canals feeding Baghdad.[2804] Al-Ramhormuzi (912-953) wrote *Ajaib al-Hind* (the Marvels of India), where he describes the seas and islands, which he saw himself, or about which he heard, also including information on China, the Indies, Japan, Java, Sumatra, Abyssinia and Madagascar.[2805] Al-Ramhormuzi gives us a recollection of long voyage of discovery and bold adventures, describing the explorations of the sailor Abhara of Kirmn, who was shipwrecked in a far off island south of the China Seas,[2806] and his description of these new islands leads to the view that he might have landed in Australia or New Zealand.[2807] Al-Masu'di contributed a lot to geographical knowledge. His description of the land and people of Tibet says:

'Tibet is gifted with strange qualities in its water, air, plains and mountains. The inhabitants are so happy that they never stop laughing as they are not troubled by sadness, grief or worries. Fruits, meadows and rivers are abundant in this country.... One finds there many cities and fortified places.'[2808]

[2800] In Ibn al-Nadim: *Kitab al-Fihrist*; ed. Flugel; Leipzig; p. 52.
[2801] Al-Djahiz: *Kitab al-Hayawan;* Cairo; 1936-44; in six vols; Al-Djahiz in *Encyclopaedia of Islam;* vol 1; p. 1000
[2802] J. Jolivet; R. Rashed: Al-Kindi; *Dictionary of Scientific Biography;* Vol 15; Supplement I; pp. 261-6.
Ibn Al-Nadim: *The Fihrist of Ibn al-Nadim;* edited and translated by Bayard Dodge (Columbia University Press; New York; 1970), pp. 615-26.
[2803] S.M.Z. Alavi: *Arabic Geography*, op cit, p. 27.
[2804] G. Sarton: *Introduction*: Vol 1; op cit; p. 621.
[2805] Al-Ramhurmuzi: *Ajaib al-Hind*; Ed Van der Lith (Leyden; 1883).
[2806] Ibid; p. 88.
[2807] S.M.Z. Alavi: *Arabic Geography*, op cit, p. 76.
[2808] Al-Masu'di: *Muruj al-Dahab;* ed. De Meynard (Paris; 1861), vol 1; pp. 418-9.

Al-Biruni's Chronology (*al-Athar . . .*)[2809] combines the purely literary and historical sources of medieval sects and nations with the astronomical lore about their calendars, feasts, and astronomical parameters used in their rituals.[2810] Al-Biruni's discussion of the Jewish calendar, for example, is the most extensive medieval technical and dogmatic exposition on the subject; and was never matched, even by the Hebrew sources, according to Saliba.[2811] Al-Biruni's India[2812] is a record of facts about Indian society in all its facets.[2813] Being an encyclopaedic scientist, according to Saliba, he in effect manages to bring together a comprehensive survey of Indian intellectual achievements and social practices as they existed around 1030.[2814]

Yaqut al-Hamawi's (d. 1229) *Mu'jam al-Buldan* (Dictionary of Countries),[2815] is an immense compilation of geographical facts listed in alphabetical order, dealing with geography in the broadest manner-astronomical, physical, historical, and archaeological.[2816] It attempts at fixing the spellings of place names and gives their geographical positions, boundaries and coordinates.[2817] He covers cities, rivers, mountains and deserts as well as seas and islands, and he also provides information on eminent residents of places, adding anecdotes and other interesting facts.[2818] His work includes accounts from earlier sources and also his own observations, resulting from his travels to Persia, Arabia, Iraq and Egypt. For every country, region, town and city, he cites monuments, recounts history, and describes people, all the while insisting on the accuracy and rigour of his information,[2819] which, as Miquel notes, has served as an excellent source for reference.[2820] For Yaqut, *Akhbar* (Usages of the Prophet) was the fountain head of all knowledge and wisdom, and he also

[2809] Al-Biruni: *Chronology of Ancient Nations*; Edward C. Sachau ed. and trans. (1879).
[2810] G. Saliba: Biruni; *Dictionary of the Middle Ages*, op cit; Vol 2; pp. 248-51; at op cit; p. 249.
[2811] Ibid.
[2812] *Alberuni's India,* Edward C. Sachau, trans. (1888), abridged in Ainslie T. Embree, ed., Alberuni's India (1971).
[2813] G. Saliba: Biruni; *Dictionary of Middle Ages*; op cit; p. 249.
[2814] Ibid.
[2815] Yaqut, Ibn Abd Allah al-Hamawi: *Jacut's Geographisches Worterbuch,* ed. F. Wustenfeld. 6 vols (Leipzig, 1866-70).
[2816] G. Sarton: *Introduction*; op cit; vol 2; p. 41.
[2817] S.M. Ahmad: *History;* op cit; p. 181.
[2818] Ibid.
[2819] C Bouamrane-L Gardet: *Panorama de la pensee Islamique* (Sindbad; Paris 1984), at p. 260.
[2820] A. Miquel: Geography, in the Encyclopaedia (Rashed ed), op cit, pp 796-812 at p 809.

believed in the intrinsic relationship between history and geography, and insisted on the importance of orthography of place names.[2821]

Ibn Said al-Maghribi (1214-1274) wrote *Kitab al-Djughrafiya* (The Geography Book) where he gives the latitudes and longitudes of all the places he cites, and where he adds information provided by contemporaries, which cannot be found in Al-Idrisi, for instance.[2822] He dwells on the Indian Ocean islands, coastal towns and cities, giving for each the length of the coast, describing the land, length of mountains, distances between places and so on.[2823] In his map, the *terra incognita* in the southern quarter of the earth is replaced by sea and the Indian Ocean is united with the Atlantic south of Africa whose southern part is fork shaped.[2824]

Al-Dimashqi (d.1326-7), a Syrian descendant of the Ansars (the early helpers of the Prophet),[2825] wrote *Kitab nukhbat al-dahr fi ajaib al-barr wal bahr* (Selection of the Age on the Wonders of the Land and the Sea).[2826] The book includes such diverse topics as the configuration of the earth, eleven chapters on the formation of mountains, the sea and its motions, tides, etc.[2827] The work also gives detailed accounts on the Indian Ocean, the Western Pacific, the China Sea, and eight chapters on its islands.[2828] This includes the populations, customs and flora, and interestingly fauna. On the island of Komor, also called Malay Island, for instance, he writes, lives the giant bird, the Rokh, whose eggs are like cupolas, the story being that some sailors cooked one such egg, and were pursued by the Rokh, carrying huge rocks, which it hurled at them, the sailors only escaping with their lives under the cover of night.[2829]

Abu'l Fida (b. Damascus 1273-d. Hama 1331) stands out as one of those singular characters of Muslim civilisation who fought wars and wrote at the same time (just like the historian Usama Ibn Munqidh, and the cartographer Piri Reis). From the age of twelve he fought both crusaders and Mongols.[2830] His family lost its estates during his youth, which he recovered in 1312 through his fidelity to the Mamluks whom he served as

[2821] S.M. Ahmad: History; op cit; p. 181.
[2822] Ibn Said: *Kitab al-Jughrafiya*; ed. Ismail Al-Arabi (Beirut; 1970).
[2823] M.A. Tolmacheva: Geography; op cit; 393.
[2824] See L. Bagrow and R.A. Skelton: *History of Cartography* (London; 1964); and S.M. Ahmad: *History;* op cit; p. 193.
[2825] G. Sarton: *Introduction*; op cit; vol 3; p. 800.
[2826] The work was edited by A.F. Mehren; quarto, 375 pp. (St Petersburg; 1866).
[2827] G. Sarton: *Introduction;* op cit; vol 3; p. 800.
[2828] Ibid.
[2829] G. Ferrand: *Relations de Voyages*; pp. 363-93.
[2830] J. Vernet: Abu'l Fida; in *Dictionary of Scientific Biography;* op cit; vol 1; pp. 28-9; at p. 28.

vassal prince until his death.[2831] His treatise *Taqwim al-Buldan (*A Sketch of the Countries*)* was known quite early in the Latin West, with many translations of it, either partial or complete.[2832] It includes twenty eight chapters, with a prologue that contains interesting observations such as the gain or loss of day according to the direction in which one goes around the earth, and the assertion that three quarters of the earth's surface is covered with water.[2833] Abu'l Fida includes in the introduction al-Biruni's view on the *terra incognita*, quoting al-Biruni's theory that between the African continent south of the sources of the Nile and the *terra incognita* there were channels of water connecting the Indian Ocean with the Atlantic.[2834] It is not unlikely that his work might have reached Tangiers and might have influenced the Portuguese sailors who searched for an entry into the Indian Ocean from South Africa.[2835] In the mid 17th century, Abu'l Fida's work had an unedited translation by Schickard, and Gravious published in London extracts relating to Khwarizm and Transoxonia.[2836] A Latin translation was made in Leiden in 1746 by Reiske,[2837] whilst Reinaud and de Slane edited the complete text.[2838] The French translation was by Reinaud and Guyard, completed in 1883.[2839] Possibly one of the most important aspects of Abu al-Fida's work was his observations of the spherical shape of the earth;[2840] a crucial matter for the progress of geography, and to receive more attention further on.

In Western Islam, the first geographer to mention is Al-Bakri (b.ca 1010; d. 1094) whose *Kitab al-massalik wal mamlaik* (Book of the Roads and Kingdoms), completed in 1068, has been partly preserved.[2841] This work is a description of land and sea routes written in order to facilitate travel, and which also includes historical and social data.[2842] It includes a description of Slavic and Nordic peoples, and most importantly a description of North Africa and Spain, including data about the Sahara

[2831] Ibid.
[2832] C. de Vaux: *Les Penseurs*, op cit, p. 13.
[2833] J. Vernet: Abu'l Fida; op cit; p. 29.
[2834] I.J. Krckovskij: *Izbrannye Socinenja,*. op cit; pp. 394-5. S.M. Ahmad: *History*; op cit; p. 197.
[2835] Ibid.
[2836] J. Greaves or Gravius; (1602-52) (London; 1650).
[2837] J. J. Reiske (Leipzig; 1866; reprinted 1886).
[2838] J.T. Reinaud and Baron de Slane (Paris; 1840).
[2839] J.T. Reinaud and S. Guyard ed: *Geographie d'Aboulfeda*, 2 vols (Paris, 1848-83).
[2840] Carra de Vaux: *Les Penseurs,* op cit; pp 21-2.
[2841] J. Vernet: Al-Bakri: *Dictionary of Scientific Biography*; op cit; vol 1; p. 413-4. at p. 413.
[2842] Ibid; p. 414.

routes.[2843] Al-Bakri also wrote lexicographical work on place names in poetry and on the traditions of the Prophet.[2844] Remarkably, for a man who never left the Iberian Peninsula, he was noted for his methodical approach, his ever alert curiosity, his attention to detail, and the serious approach to information of a wary investigator.[2845]

Abu Hamid al-Gharnati (1080-1160), from Grenada, made many travels, leaving his home in 1114 for Egypt, then returned to his native town, before leaving again in 1117 for Sardinia, Sicily, Alexandria, and Cairo, then Baghdad, Iran, crossing the Caspian Sea, reaching the mouth of the Volga. He then made three journeys to Khwarizm, and visited Hungary, before passing the last years of his life in Baghdad, Mosul, and then Damascus, where he died in 1160.[2846] It was in Mosul, where he completed his work *Tuhfat al-Albab wa Nukhbat al-Ajaib* (A Book of Wonders), which is divided into four chapters, the first dealing with the world's inhabitants; the second making a description of wonders of countries and unique buildings; the third describing the sea and its wonderful animals, volcanoes on their islands, etc; the fourth dealing with tombs and pits containing bones.[2847] The author collected information from witnesses but also from his own observation. He saw, for instance, the Pillars of Hercules near Gibraltar a short while before their destruction in 1145, and he was one of the last persons to see the tower of Alexandria in its complete form, as well as the obelisk at Ain Shams, near Cairo, before it crumbled in 1160, and he also provides valuable information on Europe.[2848] Much of Al-Gharnati's work can be found in Al-Qazwini's and other subsequent Muslim geographers' works.[2849]

The travels of the Valencia born, Ibn Jubair (Ibn Jubayr) (d. ca. 1217), offer remarkable accounts, amongst the rarest, of Muslims living under Christian rule in both Sicily, during the reign of William II (the Good) (r. 1166-1189), and in the East, under crusader hegemony, in the time of Salah Eddin (Saladin) (d. 1193).[2850] His accounts of Muslims under Christian rule are to this day used to form a precise picture of Muslim status under Christian rule in the medieval period as will be seen in Part Three of this work. The English version tells the reason for his travels,

[2843] Ibid.
[2844] G. Wiet et al: *History*; op cit; p.659.
[2845] Ibid.
[2846] S.M. Maqbul Ahmad: *History;* op cit; p. 167.
[2847] According to S.E. U. Hasham, Dubler published the text of his work with a Spanish tr. Madrid; 1953 in S.M. Maqbul: *History*; p. 168.
[2848] S.M. Maqbul Ahmad: *History*; op cit; p. 168.
[2849] Ibid.
[2850] Ibn Jubayr: *Voyages*, trans with notes by M. Gaudefroy Demombynes (Paris, 1949-65).

that as a secretary for the ruler of Granada in 1182, he was forced by that said ruler to drink seven cups of wine.[2851] To expiate his godless act, Ibn Jubayr decided to perform the duty of Hajj. He left Granada on 1183 on an itinerary, with all the stops well marked by two maps, one for the East, and the other for the West. One of the first places he reached, Alexandria in Egypt, impressed him greatly, especially its famed giant lighthouse.[2852] He says that it was visible from a distance of some seventy miles, its height 150 times the size of a man, its number of stairways, entrances and rooms quite amazing, and also including a mosque built in its summit, thus consecrating a monument from pagan antiquity to Islam and one Thursday, he himself prayed in it.[2853] During his stay at Makkah, which lasted over nine months, he makes good descriptions of the sites there, including a visit to Madinah where lay the tombs of the Prophet and early caliphs. He then returned home via Kufa, Baghdad, Mosul, Aleppo and Damascus, and on a Genoese ship caught in Acre, he returned west, via Sicily. Off the coast of Messina, the ship was caught in such a violent storm, the Christian passengers on board gave in to despair, while 'the Muslims submitted themselves to the decree of the Lord.'[2854] Eventually the passengers survived, and Ibn Jubayr ends his travel narrations in Sicily, recounting the activity of the volcanoes, and the life of Muslims under Norman rule. He was obviously impressed by Palermo, which he describes as: 'the metropolis of the islands, combining the benefits of wealth and splendour, and having all that you could wish of beauty, real or apparent, and all the needs of subsistence, mature and fresh.'[2855]

Ibn Battuta's (d 1377) *Rihla* is an account of travels that took him from Tangiers through North Africa, Syria, Iraq, Iran, reaching India in 1325.[2856] In 1332, he went overland through Egypt and Syria; then Istambul, crisscrossed Asia Minor, crossed the Black Sea to the Crimea, and made his way overland via the Islamised Mongol Golden Horde's territory, through Samarqand, Bukhara and Afghanistan. He reached the Indus River frontier of India in late 1333. He became chief judge of Delhi and in 1342 became the Sultan's envoy to the Mongols in China. The trip also took him to the Maldives, Bengal, Assam, Sumatra, and finally to the

[2851] *The travels of Ibn Jubayr*; tr from the original Arabic with introduction and notes, by R.J. C. Broadhurst (J. Cape, London, 1952).
[2852] Ibid; pp. 32-3.
[2853] I.R. Netton: *Seek Knowledge; Thought and Travel in the House of Islam* (Curzon Press; Richmond; 1996), p. 99.
[2854] Ibn Jubayr: Travels (Broadhurst) op cit; p. 336 ff.
[2855] Ibid; pp 348 fwd.
[2856] Ibn Battuta: *Voyages d'Ibn Battuta*, Arabic text accompanied by French translation by C. Defremery and B.R. Sanguinetti, preface and notes by Vincent Monteil, I-IV (Paris, 1968), reprint of the 1854 ed.

Chinese city of Zaytun, and possibly Peking. He returned to Morocco in 1349, and completed dictation of his travels to Ibn Jazayy in 1357.[2857] His work was translated into French, and also partially into English by Gibb.[2858] The merit of Gibb's version is that it gives a very useful and lengthy introduction on Ibn Battuta's life. We learn, for instance, that during his journey from Alexandria to the Maghreb, on two occasions, he narrowly escaped capture by Christian pirates, but still his love for travel was never exhausted. From each part visited, Ibn Battuta relates his experiences and observations. He was particularly interested in political conditions and the glories of foreign rulers; in economic factors; in all forms of strange customs, such as those of marriage and burial, in the construction of Indian beds, and the kind of fuel used in China.[2859] Ibn Battuta's accounts of some parts of the world, such as 14th century India, the Maldives, southern Russia, and Black Africa remain unique, he being the only medieval author to give some specific accounts of such places.[2860] On India, for instance, he describes in detail the reign of Muhammad B Tughluq, and contemporary Delhi, its population, its size, its diverse parts, its attractive sites, etc.[2861] Ibn Battuta also caught the Muslim world straight in the aftermath of the Mongol devastation (1253-1320), and thus offers first accounts of the effects of such onslaught. He also describes buildings and architectural accomplishments, which are no more. He speaks, for instance, of madrasas, and also of hospitals, some of the earliest institutions of Islam, and their structures,[2862] which have since gone. Also interesting is that he expresses early Islamic awareness of certain natural manifestations, such as relating to the River Nile, as he says:

> 'The Egyptian Nile surpasses all rivers of the earth in sweetness of taste, length, of course, and utility. No other river in the world can show such a continuous series of towns and villages along its banks, or a basin so intensely cultivated. Its course is from south to north, contrary to all other [great] rivers. One extraordinary thing about it is that it begins to rise in the extreme hot weather, at

[2857] R.B. Winder: Ibn Battuta; in *The Genius of Arab Civilisation;* J.R. Hayes ed; op cit; p. 210.
[2858] Ibn Battuta: *Travels in Asia and Africa;* tr and selected by H.A.R. Gibb (Routledge; London, 1929).
[2859] F. Rosenthal: Ibn Battuta; *Dictionary of Scientific Biography*; op cit; vol 1; p. 517.
[2860] Ibid.
[2861] Ibn Battuta: Defremery (ed); vol 2; p. 16; etc.
[2862] F. Farag: Why Europe responded to the Muslims medical achievements; in *Arabica,* XXV, Fascicule 3; pp. 292-308. p. 295.

> the time when rivers generally diminish and dry up, and begins to subside just when rivers begin to increase and overflow.'[2863]

His interest in the customs of people is well defined, whether with regard to the idolatry of the inhabitants of Ceylon, or the harshness of the Turks towards thieves, whilst China, he informs us:

> 'Is of vast extent, and abounding in produce, fruits, grain, gold and silver. It is traversed by the river called the 'Water of Life,' which rises in some mountains, called the Mountains of the Apes, near the city of Khan Baliq (Peking) and flows through the centre of China for the space of six months' journey, until it reaches Sin as Sin (Canton). It is bordered by villages, fields and gardens, and bazaars, just like the Egyptian Nile, only that this riverside is even more richly cultivated and populous, and there are many waterwheels on it. In the land of China there is abundant sugar cane, equal, nay superior, in quality to that of Egypt.' [2864]

About the manufacture of Chinese porcelain, he says:

> 'The Chinese pottery [porcelain] is manufactured only in the towns of Zaytun and Sin Kalan. It is made of the soil of some mountains in that district, which takes fire like charcoal, as we shall relate subsequently. They mix it with some stones which they have, burn the whole for three days, then pour water over it. This gives a kind of clay which they cause to ferment. The best quality porcelain is made from clay that has fermented for a complete month, but no more, the poorer quality [from clay] that has fermented ten days… It [porcelain] is exported to India and other countries, even reaching as far as our own lands in the West, and it is the finest of all makes of pottery.'[2865]

Despite all such extensive detailed accounts, just considered, most such accounts are unique in universal knowledge, whether in terms of quality, variety, or volume, Ashtor, like most 'historians' of geography, derides Muslim geography, putting focus on what seemingly appear to him are shortcomings of such geography, for instance, holding that:

> 'Muslim writings of the ninth century and early tenth century reveal an almost complete ignorance of the geography of Europe. Even the European shores of the Mediterranean were unknown to the Arabs. This is a clear proof that there were no trade relations...

[2863] Ibn Battuta: *Travels*; (Gibb); op cit; p.52.
[2864] Ibid; p. 282.
[2865] Ibid; pp. 282-3.

> All Arab geographers of this period confuse Rome and Constantinople, and repeat legendary stories.'[2866]

This is baffling when one reads about Islamic geographical achievements as amply shown already in this chapter, that any shortcoming, however small, should be amplified so much as to demean the great accomplishments, a criticism which is also groundless, and fallacious, for part one of this work has amply shown that Muslims traded with Europe in the late 7th and 8th centuries, and 9th century Western accounts by Church authorities, themselves, speak of such trade. The biographies of Pope Gregory IV (Pope 827-844) and of Leo IV (Pope 847-855), for instance, speak of Spanish textiles along with those of Byzantium.[2867] As for Muslim geographers' knowledge of Europe, it was already well advanced in the 10th century, and had earlier foundations. Historical evidence proves, as Kramers points out, that since the 8th century Muslim travellers and traders are to be found in Italian towns and Constantinople.[2868] Many accounts of other European places were reports of authentic journeys, such as Ibrahim ibn Ya'qub's journey from Spain to Germany (ca. 965).[2869] The trips by Al-Ghazal's diplomatic mission to the Vikings of Ireland in 845 have been noted.[2870] Dunlop, although himself reserved about whether actually the Muslims visited such Western shores, except Ireland, still notes good Islamic knowledge of the Western Christian shores;[2871] and also of the islands lying off the continent of western Europe and Africa in *al-Bahr al-Muhit* (the Circumambient Ocean) otherwise called by such names as *Bahr az-Zulmat* (the Sea of Darkness) or *al-Bahr al-Akhdar* (the Green Sea).[2872] The British Isles (Jaza'ir Bartaniya or Baruniya-twelve in number according to al-Battani (850-929), were known, with Ankartara, Inkiltara, Lanqaltara (l'Angleterre), Squsiya (Scotia) and Irlanda or Birlanda (Ireland).[2873] Dunlop also tells of the sea adventures of Muslim sailors departing from Lisbon, and their discovery of unknown lands, an episode dating from the

[2866] E. Ashtor: *A Social;* op cit; p. 105.
[2867] G. Migeon: Arts Plastiques et industriels; ii; p. 320; in S.M. Imamuddin: *Muslim*; op cit; p. 112.
[2868] J. H. Kramers: *Islamic Geography and Commerce;* extracted from The Legacy of Islam; edited by T Arnold and A. Guillaume; pp. 79-106; repr in *The Islamic World and the West;* Edited by A.R. Lewis (John Wiley and Sons, London; 1970), pp. 66-78. p. 76.
[2869] M.A. Tolmacheva: Geography; op cit; 393.
[2870] W.E.D. Allen: The Poet and the Spae-wife; op cit; pp. 1-14.
[2871] D.M. Dunlop: *Arab Civilisation*; p.160.
[2872] Ibid.
[2873] Qazwini, ed. Wustenfeld, ii, 388; Eng. tr. in D. M. Dunlop. 'The British Isles according to medieval Arabic Authors', *Islamic Quarterly*, iv (1957), pp 11-28 at pp 19-20; and D.M. Dunlop: *Arab Civilisation*; p.160.

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In view of all such accounts, which could have been vastly extended, generalised assertions deriding Islamic geography, when no other geography can match its richness, especially at such an early stage, only serve to highlight both poor scholarship, and narrow hostile writing on the part of mainstream Western authors.

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[2875] S.F.D. Hughes: Scandinavia in Arabic sources; *Dictionary of the Middle Ages*; op cit; Vol 10. pp 706-8.
[2876] Harris Birkeland: *Nordens hidstorie I middelalderen etter arabiskenkilder*, Norske Videnskaps-Akademi i Oslo, Skrifter, Hist.-Filos. Klasse, 2 Scriffer, 1954, 2 (1954).
[2877] In S.F. D. Hughes: Scandinavia; op cit; p.706.
[2878] Ibid; pp 706-7.
[2879] M. Canard: Ibn Fadlan, in *Encyclopaedia of Islam*; New edition, vol 3 (Brill; Leiden, 1971), p. 759.
[2880] S. Al-Dahhan: *Risalat Ibn Fadlan*; Dar Sadir (Beirut; 1993).
[2881] For a long account of Ibn Fadlan's travel to the Volga Bulgars, see M. Canard: Les Relations de voyage d'Ibn Fadlan chez les Bulgares de la Volga; In *Annales de l'Institut d'Etudes Orientales*; Vol 16; 1958; pp 41-146; for extensive extracts on such travels see S.M. Ahmad: *A History*, op cit; and for a summary see M. Dunlop: *Arab Civilisation,* pp 169-70.
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The need for maps was imposed on Muslims by conditions pertaining to the historical situation, which followed the rise and early advance of Islam in the late 7th-early 8th century. Tibbetts notes how, prior to the establishment of Islam in the 7th century, there is no evidence that the early Arabs accepted the idea of representing landscape in a systematic way.[2883] Toward the end of the first century of Islam, we do find a few literary references to military maps. A map was prepared ca 83 H/702 of the country of Daylam, south of the Caspian Sea, for al-Hajaj Ibn Yusuf (d. 714), the governor of the Eastern Province so that the military situation could be understood from his capital in Iraq.[2884] Similarly he ordered a plan for Bukhara so that he could acquaint himself with the layout of the city while preparing to besiege it in 707.[2885] A map of the swamps of al-Batiba near Basra was also said to be available in the time of the Abbasid Caliph, al-Mansur, this time because of a dispute over fresh water.[2886] A plan was also reputedly drawn in 758 for the round city of Baghdad planned for Caliph al-Mansur. Since this was a strongly walled fortress in which only the privileged lived, the drawing was less a city plan than an architect's site plan,[2887] but since the city had a diameter of two kilometres or more, the plan may have been a substantial cartographic attempt.[2888]

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[2883] G. Tibbetts: The Beginnings of a Cartographic Tradition; in *The History of Cartography*; J.B. Harley and d. Woodward ed; op cit; pp. 90-107; at p. 90.
[2884] Ibn al-Faqih: *Kitab l-Buldan*; see *Compendium libri kitab al-Boldan;* ed. M. de Goeje; Bibliotheca Geographorum Arabicorum; vol 5 (Leiden; 1885; (reprinted 1967), p. 283.
[2885] Al-Tabari: *Tarikh al-Rusul was al-Muluk*; see *Annales quos scripsit.. al-Tabari;* ed. M. de Goeje; 15 vols (Leiden; 1879-1901, repr 1964-5), 2. 1199.
[2886] Al-Baladhuri: *Futuh al-Buldan*; see *Liber expugnationis regionum;* ed. M.de Goeje (Leiden, 1866); p. 371.
[2887] Al-Yaqubi: *Kitab al-Buldan*; see *Kitab al-Boldan*; ed. M. de Goeje; Bibliotheca Geographorum Arabicorum; vol 7 (Leiden; 1892; repr 1967), p. 238.
[2888] G. Tibbetts: The Beginnings of a Cartographic Tradition; op cit; p. 90.
[2889] Ibid; p. 95.

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universe with the spheres, the stars, land and the sea, inhabited and barren regions of the earth, settlements of people, cities, etc.[2890] Al-Masu'di also insists that this map was better than anything that preceded it.[2891] Al-Zuhry (d. 1154? 1161?) claims that his own *Jughrafya* was based on a copy of al-Fazari's *Jughrafya*, which itself was based on the *Jughrafya* of Caliph al-Mamun, in whose elaboration more than seventy scholars had participated.[2892]

Muslim map makers initially relied on their Greek predecessor, Ptolemy, but, soon, contrary to what is generally asserted, the Muslims deviated considerably from Greek geography, which became in their hands completely redundant. As Bagrow observes, whilst Muslims held his work, the *Almagest* in high esteem, they soon forgot his *Geographia*.[2893] And the view that Muslim cartography 'turned back the clock when it broke away from Greek traditions represented by Ptolemy, is unfounded,' Bagrow insists.[2894] The Muslims had early felt the need for accurate determination of position, if for no other reason than that the correct orientation of their mosques depended upon such knowledge.[2895] As Koyre points out, Muslims took on the role as the precursors of the art of precision and accuracy.[2896] Every Muslim scientist gave himself to the improvement of methods of finding these geographical coordinates, and with commendable results: their figures were a considerable improvement on those given by Ptolemy.[2897] Tangier as measured from Alexandria, for instance, was not $53^0 30'$ but $35^0 41'$; Ptolemy's measurement of the Mediterranean was 19 degrees in excess.[2898] Moreover, as noted by al-Biruni, places east were found in the west, and vice versa.[2899]
Amongst the earliest to make amendments to Greek geography, and contribute a more accurate knowledge and mapping of the earth was Al-Khwarizmi (d. 863). His *Surat al-Ard*[2900] (Image of the Earth) is a rich

[2890] Al-Masu'di: *Tanbih;* Ed M. De Goeje (Leiden; 1894); p. 33.
[2891] Ibid.
[2892] In M. Hadj Sadok: *Kitab al-Jughrafiya; Bulletin d'Etudes Orientales*; 21 (1968), pp. 7-312; esp 306.
[2893] L. Bagrow: *History*; op cit; p. 55.
[2894] Ibid; p. 58.
[2895] G.H. T. Kimble: *Geography in the Middle Ages;* op cit; p. 62.
[2896] A. Koyre in R. Hollander: la Connaissance de la Geographie du globe a l'epoque de Christophe Colomb; in *Acta Geographica*, No 101 (1995), pp, 19-53; at p. 29.
[2897] G.H. T. Kimble: *Geography in the Middle Ages;* p. 62-3.
[2898] G. Le Bon: *La Civilisation*; op cit; p. 371.
[2899] Al-Biruni: The Book; in N. Ahmad, *Muslim contribution*, op cit; p 35.
[2900] Al-Khwarizmi: *Surat al-Ard*, Ed. Hans v. Mzik (Leipzig, 1926).

treatise on Mathematical geography.[2901] It corrects and fills gaps left by Ptolemy.[2902] Al Khwarizmi's tables cut down Ptolemy's estimate of the length of the Mediterranean Sea from 62 degrees to about 52;[2903] a length which was further cut by Al-Zarqali of Spain.[2904] Al-Khwarizmi's *Surat al-Ard*, more importantly, signals a new form of geography, where the world is in the form of a sphere.[2905] It is divided in its northern half into seven longitudinal bands from the equator: the *iqlim,* reviewed and corrected according to new data and knowledge, with latitudes and longitudes locating the principal mountains, rivers, seas and towns on the picture.[2906] It gives latitudes and longitudes for 2402 localities as a basis for a world map, and also includes latitudes and longitudes for cities, islands, and geographical regions.[2907]
Al-Zarqali gives the length of the Mediterranean Sea in his commentary on the Toledo tables as 42 degrees, which is almost exact (Ptolemy gives 62 degrees), whilst al-Marrakushi gives a list of 135 coordinates which, for accuracy, deserve to be regarded as one of the most important contributions of Muslims to mathematical geography.[2908] These and other Muslim contributions led to more precise location of places, old and new, and contradict sharply widely held opinions by modern historians, such as Parry, who asserts that: 'The scholars of early fifteenth century Europe had no reliable criteria for criticising Ptolemy.'[2909]

In order to calculate the terrestrial latitude and longitude of places, the Muslims developed a number of techniques and methods. The method of finding latitudes is here stated by Al-Battani:

> 'If you want to know the latitude of any given town, then, first of all, measure the altitude of the sun at noon (i.e when it crosses the meridian) in any direction. When you know the altitude then, find out the declination of the Sun at that time, if it is north then deduct it from the altitude, and if it is south, add it to the altitude.

[2901] D.M. Dunlop: *Arab Civilisation,* op cit, p. 150.
[2902] A. Miquel: Geography, in the *Encyclopaedia* (Rashed ed), op cit, pp 796-812, at p. 796.
[2903] J.K. Wright: Notes on the Knowledge of latitudes and longitudes in the middle ages; *ISIS* Vol 5; pp. 75-98; at p. 89.
[2904] J.M. Millas-Vallicrosa: *Estudios sobre Azarquiel* (Madrid; Grenada; 1943-1950).
[2905] A. Miquel: Geography, op cit, pp 796-7.
[2906] Ibid.
[2907] Entry on al-Khwarizmi by John J O'Connor and Edmund F Robertson: *Arabic Mathematics, a Forgotten Brilliance*; at: http://www-history.mcs.st-andrews.ac.uk/history/index.html
[2908] Ibid.
[2909] J.H. Parry: *The Age of Reconnaissance* (Weidenfeld and Nicholson; London; 1966), p. 13.

This gives the altitude of Aries or Libra at that town. Subtract this from 90^0, the remainder will be the latitude of the town.'[2910]

As regards longitude, which is the angular distance east or west from the standard meridian to that of any place, all they had to do was to find out at any given instant, the time and the standard meridian (Muslim geographers generally adopted the Fortunes islands as the standard meridian; others adopted the meridian of Arin (a place in India)), as well as the local time at the station concerned, and then, by converting the difference of the time into degrees they obtained the longitude of the place.[2911] They faced, of course, the problem of finding the correct local time, which they eventually solved by means of the eclipse of the moon because it supplied the requisite information, i.e the time at any given instant at the prime meridian as well as the local time at the station concerned.[2912] So Muslim geographers collected from various quarters the local times at which the eclipse occurred, and from that data, they easily calculated and verified the longitudes of the places of observation.[2913]

Al-Biruni made further contributions towards more accurate measurements in setting the foundations for modern mathematical geography.[2914] He carried geodetic measurements and determined with remarkable precision the coordinates of a number of places, besides introducing a simplified method of stereographic projection.[2915] In his works he gives the theory behind two different projections, one of which would be known today as an azimuth equidistant projection and the other as a globular projection.[2916] Al-Biruni also criticises the projections of Ptolemy and Marinus.[2917] Al-Biruni mentions in some detail the measurements of the degree of latitude.[2918] He carried this out in Khwarizm and in Ghazna, and he produced a new method of measurement by using a convenient mountain from which the horizon could be

[2910] Al-Battani: *Kitab al-Zij al-Sabi*; ed. A. Nallino (Rome; 1899), vol 3; pp. 43-4.
[2911] S.M.Z. Alavi: *Arabic Geography*, op cit, p. 48-9.
[2912] C. Shoy: Muslim geography of the Middle Ages; in *Geographical Review* (1924); vol XIV; p. 206.
[2913] S.M.Z. Alavi: *Arabic Geography*, op cit, p. 49.
[2914] E.S. Kennedy: Mathematical geography, in the *Encyclopaedia,* (Rashed ed) op cit, pp. 185-201; pp 194-9 in particular.
[2915] G. Sarton: *Introduction;* op cit; Vol 1; p. 699.
[2916] E. Kennedy and M.T. Debarnot: two mappings proposed by Biruni; in *Zeitschrift fur Geschchte der Arabisch Islamichen Wissensschaften*; 1 (1984); 145-47.
[2917] G.R. Tibbetts: Later Cartographic Developments; *History of Cartography (*J.B. Harley and D. Woodward ed) op cit; pp. 137-55; at. p.141.
[2918] Ibid.

observed.[2919] Al-Biruni also sought to measure the difference in longitude between two places using the distance between them in miles.[2920] This was difficult since the direct distances between places could not be worked out with accuracy; however, he produced a result for the longitude of Ghazna east of Baghdad, setting out the theory behind this operation so that it was there for any later scholar to improve.[2921] Al-Biruni also took it for granted that the earth is round, noting "the attraction of all things towards the centre of the earth," and remarked that astronomic data can be explained as well by supposing that the earth turns daily on its axis and annually around the sun, as by the reverse hypothesis.[2922]

A further impetus to the development of cartography took place in the 10th century, when a school of geography rose and exerted a decisive impact on the subject.[2923] This school's distinctive feature was that texts and maps went together, each text accompanied by a set of twenty-one maps: one for each of the twenty climes of the Islamic lands, and one world map.[2924] Members of this school were al-Balkhi and his followers: al-Istakhri, Ibn Hawqal, and al-Muqaddasi.[2925] The inspiration of this school was al-Balkhi (born Ahmed B. Sahl, about 849-50) near Balkh from which he took his name al-Balkhi.[2926] The son of a schoolmaster, he travelled as a young man to Iraq, met the celebrated al-Kindi, and under the latter's influence became enthusiastic about the exact sciences.[2927] In 920 or a little later, he wrote *Kitab al-Ashkal or Suwar al-Akalim* (The Book of the Forms and the Images of the Continents) a text accompanying maps of the inhabited world, which was unusual then.[2928] The first map is a map of the world, circular in form, and Makkah its centre; the world is surrounded by the ocean, and two gulfs enter the continent. These gulfs are the Mediterranean and the Indian Ocean; Arabia is seen as the centre of the world, and next North Africa, Muslim Spain, Egypt, and Syria.[2929] The second part of the

[2919] S.H. Barani: Muslim researches in geodesy; in *Al-Biruni Commemoration Volume (*Calcutta; Iran Society; 1951), 1-52; esp pp. 33-9.
[2920] J.H. Kramers: Al-Biruni's Determination of Geographical Longitude; in *Al-Biruni Commemoration Volume*; op cit; pp. 177-93.
[2921] Ibid; Note 26.
[2922] Carra De Vaux: *Les Penseurs*; op cit; vol II; p. 217.
[2923] J.H. Kramers: Geography; op cit; pp 85-6.
[2924] M.A. Tolmacheva: Geography; op cit; p. 392.
[2925] Ibid.
[2926] D. M. Dunlop: *Arab Civilisation*, op cit, p. 164.
[2927] Ibid.
[2928] De Goeje: *Die Istakhri-balkhi Frage*, Z.D.M. G. xxv, 42599 in S.M. Z Alavi: *Arabic Geography*, op cit, p. 37.
[2929] J.H. Kramers: Geography; op cit; p. 85-6:

geographical description deals with eastern Islam. Although lost, this work impacted on those, which followed.[2930] Amongst these is Al-Istakhri's (fl. C. 950) *Kitab al-Masalik wal Mamalik* (Book of Journeys and Kingdoms) which describes lands he visited, each with a chapter and a map in colour.[2931] Coast-lines and rivers are represented under conventional forms, many of al-Istakhri's maps showing the Mediterranean in a circular or elliptical form.[2932] Ibn Hawqal (fl 977) drew 22 provincial maps of the Islamic realm, amongst these maps is one of the Nile, reproduced by Kramers in his new edition of Ibn Hawqal.[2933] From a look at the maps, it would seem quite obvious that the best representation of the Mediterranean, its shores, islands, and location of cities, amongst the early geographers is that of Ibn Hawqal.[2934] Al-Muqaddasi was the last representative of this school, creating, according to Tolmacheva, the systematic foundation of Muslim geography by discussing its uses and scopes, the geographic terminology, the various methods of division of the earth, and the value of empirical observation[2935] He was in the company of the senior sea captains, the mathematicians, the middlemen and the merchants, who had the clearest perception about the Red Sea, its ports, winds, islands, and he enquired from them about its nature and limits, their records he studied carefully, making suitable selections from them, comparing them to maps he had seen earlier.[2936] Al-Muqaddasi was the first to produce maps in natural colours. He says:

> 'In the maps we have coloured the familiar routes red, the golden sands yellow, the salt seas green, the well known rivers blue, and the principal mountains dull brown.'[2937]

Al-Muqaddasi also seems to indicate the relative importance of the towns by the differing sizes of circles, something he is very keen on in his text.[2938] In all three respects, introducing coloured maps, different colours for rivers, routes, etc, and differing sizes for urban areas, Al-Muqaddasi clearly innovated, and set up a methodology future geography was to adopt.

[2930] D. M. Dunlop: *Arab Civilisation,* op cit, p. 164.
[2931] Carra de Vaux: *Les Penseurs,* op cit, p. 8.
[2932] J. H. Kramers: Geography, op cit, p. 87.
[2933] Ibn Hawqal: *Kitab Surat al-Ard*; ed. J.J. Kramers (Leiden; 1938), p. 148.
[2934] See Plate VI; Bottom map; in S.M.Z. Alavi: *Arabic Geography;* op cit; pp. 38 and fol.
[2935] M.A. Tolmacheva: Geography; op cit; p. 392.
[2936] S. Maqbul Ahmed: *A History of Arab-Islamic Geography;* op cit; p. 96.
[2937] Al-Muqaddasi: *Ahsan al-taqasim*; Miquel's translation; op cit; p. 27 note 8.
[2938] G. Tibbetts: The Balkhi School; op cit; p. 122.

The medieval culmination of geography was probably reached with al-Idrisi (b.1101). He spent most of his working life at the court of the Normans in Sicily. The Sicilian ruler, Roger II was his patron, and thanks to his position, Al-Idrisi was able to acquire information about France, Italy, Germany and parts hitherto missing in previous Muslim works.[2939] A typical instance of his knowledge of current events is supplied by the account of the Lisbon 'wanderers',[2940] three men who went on an exploratory mission in the Atlantic Ocean, an early (9th century) adventure, some of whose details have reached us.[2941] This, in addition to its intrinsic value as being the earliest recorded voyage after the rise of Islam, deliberately undertaken for the purpose of exploring the Western ocean, provides an interesting spotlight upon the breadth of Al-Idrisi's outlook.[2942] Al-Idrisi's final output was what is commonly known as *al-Kitab al-Rujari* (The Book of Roger), which includes descriptions of the world as known then; accompanied by a spherical world map, and a larger rectangular map. The spherical map was made of a silver ball of about 400 kgs, on which were drawn the seven continents, lakes and rivers; mountains and plains, cities and routes (and distances, heights, or lengths for all),[2943] with great accuracy.[2944] The silver planisphere is lost (probably melted in the course of the centuries). Bagrow, closer to the historical truth, says that the 'silver tablet,' fell in the hands of the mob and was smashed to pieces in the year 1160;[2945] the year 1160 being when widespread massacres of Muslims, including of courtiers, took place.[2946] The large rectangular map, however, features in many works. It consists of seventy regular sheets assembled in seven rows of ten sheets each, and a small circular world map. Against today's conventions, north was at the bottom, and South on top. On this map are located hundreds of cities and detailed information of all sorts.[2947] By this map recent studies of particular regions were inspired.[2948] Al-Idrisi's map corrected many once

[2939] Carra de Vaux: *Les Penseurs,* op cit, p. 12.
[2940] C.R. Beazley: *The Dawn of Modern Geography*; op cit; vol 3; pp. 532-3.
[2941] Abrege par Gabriel Sionite, *Geographia Nubiensis* (Paris, 1619), p. 157, in Baron Carra de Vaux: *Les Penseurs*, op cit, pp. 47-9.
[2942] G.H. T. Kimble: *Geography in the Middle Ages;* op cit; p. 56.
[2943] I and L Al-Faruqi: *The Cultural Atlas*, op cit, p 334.
[2944] D. M. Dunlop: *Arab Civilisation*, op cit, p. 171.
[2945] L. Bagrow: *History;* op cit; p. 57.
[2946] See Final part of this work on the gradual phasing out of Muslims in Sicily.
[2947] K. Miller: *Weltkarte des Arabers Idrisi vom Jahre 1154* (Stuttgart, 1981), in E. S. Kennedy: mathematical, op cit, pp 199-200.
[2948] E.g: The British Isles in Beeston (1949), Germany in Hoernerbach (1938), Spain in Dozy and de Goeje (1866) and India in M Ahmad (1960), all in E.S. Kennedy: Mathematical geography, op cit, p. 200

held medieval assumptions including the perception in Europe that the world, apart from Europe, belonged to the Muslims.[2949]

Western historians claim that both Islamic geography and cartography are a reproduction of Greek maps, and worse, that knowledge of the world and the seas by the time of the Renaissance had not evolved since Ptolemy, as here held by one leading Western historian, Parry, who claims:

> 'In the process of Reconnaissance, explorers by sea, pushing rashly out in the world of the unknown, but for Ptolemy.'[2950]

This is false. In an admirably conceived appendix by Maqbul, we come across a good comparison between Ptolemaic maps and al-Idrisi's, which show how the latter made a through revision of nearly everything that Ptolemy did.[2951] This is succinctly outlined here.

* Ptolemy placed the northern limits of the known world at 63^0 N. Lat. And the southern limits at 16^0 25'' S. Lat., the total north-south extent of the known world being 79^0 25'.[2952] Al-Idrisi on the other hand, extended the northern limits to 64^0 N. Lat. without specifying the southern limits.[2953]
* Al-Idrisi divided his world map between the equator 0^0 and 64^0 N. Lat. Into 42 parallels. But the distance between one parallel and the other varies, and even within the seven climes, drawn as straight lines, the distance is not equal. Assuming that the parallels are equidistant from each other, the distance between each parallel would be approximately 1^0 35' 25''. According to Ptolemy who drew 21 parallels on his map, the distance between each parallel was 3^0. Hence the ratio as given by Ptolemy and al-Idrisi between each parallel would be 1:2. South of the Equator, al-Idrisi added space on his map equal to about the distance between two parallels. So, the total north-south distance of al-Idrisi's map (which is 79.3 cm) would be 69^0 58' 20'' as compared to Ptolemy's $79^0$25'. Thus, al-Idrisi reduced the size of his map by 9^0 26' 40''. This resulted in shifting the equator by 3^0 37' north. Since al-Idrisi included on his map all the regions shown by Ptolemy as well as some additional

[2949] W.M. Watt: *The Influence,* op cit, p 21.
[2950] J.H. Parry: *The Age of Reconnaissance* (Weidenfeld and Nicholson; London; 1966), pp. 14-5.
[2951] S.M. Ahmad: *A History of Arab-Islamic Geography;* op cit; pp. 397-407.
[2952] E.L. Stevenson: *Geography of Claudius Ptolemy* (New York; 1932), p. 160.
[2953] Al-Idrisi: *Nuzhat al-Mushtaq fi 'khtiraq al-afaq; Opus Geographicum* (Rome-Naples; 1970-84), ISMEO and Instituto Universitario Orientale di Napoli; p. 8.

countries of the Baltic Sea, the geographical positions of places were changed by him specially in the northern and the southern regions.[2954]

* In his extension of the eastern coast of Africa, al-Idrisi also differed from Ptolemy. Since al-Idrisi reduced the scale of his map, north south, the eastern coast of Africa on his map is shown turning east at approximately 4^0 Lat. N. where he places the equator, whereas according to Ptolemy, it turned eastwards at 15^0 Lat S; 80^0 Long. or at the point where he placed the Prasum Promonotry. This resulted in the reduction of the size of the Indian ocean on al-Idrisi's map.[2955]
* With regard to the Seas, Al-Idrisi counted seven seas, six of which are connected with each other by water whilst another, the Caspian, was landlocked. These seas were the Indian Ocean, the Mediterranean, the Gulf, the Red Sea, the Black Sea, the Adriatic, and the Caspian.[2956] Ptolemy counted three such seas: the Mediterranean, the Caspian, and the India Sea.[2957]
* On the Indian Ocean, al-Idrisi's map reduces the size of this ocean in comparison to the size given by Ptolemy, who considered it the largest of all seas.[2958] According to Ptolemy, it was surrounded by land on all sides, but on al-Idrisi's map, its eastern stretches are shown connected with the Pacific between 1^0 S. Lat. and 4^0 N. lat., approximately, but in the text he describes its conjunction with the Pacific at 13^0 Lat.S.[2959]
* The shape of the Caspian Sea is changed by al-Idrisi in relation to that drawn by Ptolemy; in Ptolemy's it is shown longer west to east than north to south, whereas al-Idrisi shows it longer north to south than east to west.[2960]
* Al-Idrisi introduced considerable modifications in Ptolemy's map of Europe, the shapes of some of the countries and their coastlines were changed. In many cases, the names, provincial and regional divisions were replaced by new ones. Idrisi also extended the northern limits of the inhabited world from Ptolemy's 63^0 N. lat to 64^0 N. lat. Al-Idrisi adds countries such as Poland, Norway, Sweden, etc, which are all absent in Ptolemy.[2961]

[2954] S.M. Ahmad: *A History of Arab-Islamic Geography;* op cit; p. 397.
[2955] Ibid; p. 398.
[2956] Al-Idrisi: *Opus Geographicum*; op cit; pp. 9-13.
[2957] E.L. Stevenson: *Geography of Claudius Ptolemy*; op cit; pp. 159-60.
[2958] Ibid; p. 160.
[2959] Al-Idrisi: *Opus Geographicum;* op cit; p. 9.
[2960] A. Berthelot: *L'Asie Ancienne Centrale et sud orientale d'apres Ptolemee* (Paris; 1930), p. 184; fig. 4.
[2961] S.M. Ahmad: *A History of Arab-Islamic Geography;* op cit; p. 400.

* In drawing the map of Asia, Al-Idrisi changed almost the whole map of Asia, both in respect of the Ptolemaic political boundaries as well as its physical features.
* Al-Idrisi also adds to the knowledge of places, rivers, mountains, etc, of Asia, Africa, and Europe, and also political divisions such as in North Africa. Ptolemy with regard to the latter speaks of Mauritania, Tringitania, etc, Al-Idrisi replaces them with contemporary names and divisions, and also introduces the names of the settlements of the African tribes.[2962]

To assume, as the majority, if not all Western historians, that al-Idrisi's maps did not impact on the Christian West is not just fallacious, but is also proof of poor scholarship. For, how could a Muslim geographer (Al-Idrisi) be brought to a Christian court, the leading sea-going power of the time, and create for this court first class mapping, just for his work then to be discarded. This makes no sense. It is not because modern historians have, for whatever reason, failed to show how the Christian West adopted Idrisi's knowledge that such adoption did not take place. It is impossible for such knowledge not to be adopted, for al-Idrisi's knowledge remained valued and valid for centuries. Le Bon, for instance, points out that Al-Idrisi's reference to the sources of the Nile was only matched by European discoveries in the late 19th century.[2963] More important is a detail, may be short, but highly crucial, stated by Bagrow in passing:

> 'In 1154, a few weeks before Roger's death, manuscripts of the book (Al-Idrisi's work) in Latin and Arabic were completed, together with the map, seventy sheets…'[2964]

The focus here is on the word Latin, which escaped so many, for, of course, the work by al-Idrisi did not need any translation, for it was in Latin from the outset (he was working for a Christian ruler, after all), and that's why it was easy to conceal its impact, for no medieval Western scholar needed to translate it. So, rather than being overlooked, as we read in modern Western historians' writing, this work was simply available, ready for use from the source.

A further major Islamic contribution to mapping was the greater use of instruments in search of ever more accurate calculations and locations. Amongst the instruments used are the astrolabe, the *ruba* (quadrant), the gnomon, the celestial sphere, the sundial, and the compass.[2965] Al-

[2962] Ibid; p. 404.
[2963] In G. le Bon: *La Civilisation;* op cit; p. 372.
[2964] L. Bagrow: *History;* op cit; pp. 57-8.
[2965] A. Buang: Geography in the Islamic world; in *Encyclopaedia* (Selin ed): pp 354-6: at p.356:

Khujandi (fl second half of 10th century), for instance, built a universal instrument *al-Ala al-Shamila* (the comprehensive instrument) which was used instead of the astrolabe or the quadrant, but it could be used for one latitude only. Al-Badi al-Ustrulabi al-Baghdadi (d. 1140) constructed an astrolabe which could be used for all the latitudes.[2966] Finding the latitude of any place by the use of this astrolabe can be outlined here:

> 'Take the reading in the meridional line as shown in *almuqantara* (the circle of latitude). This space equals the height of the Arctic pole from the horizon of that place. If you desire to know the latitude of the region, take the altitude of the sun in the middle of the day when the sun is in Aries or Libra. Subtract the degrees of the sun's altitude from 90, the remainder will be the latitude of the place. Supposing that the sun on that day at noon was 38^0 10 in elevation, the latitude will be 51^0 50'.'[2967]

The impact of such instruments on better mapping was obvious. Muslim maps, Bagrow remarks, show 'artistic and ingenious schematic drawings'; compasses, ruler and set square producing the necessary geometric figures.[2968]

Considering the 12th century translations from Arabic into Latin and other languages,[2969] contemporary Latin works derived from the Islamic originals, such as John of Holywood's *Tractatus de Sphaera, or Sphaera Mundi,* completed in 1233,[2970] and other forms of Islamic influence in the use of instruments,[2971] prompts the conclusion that there was a much better and more accurate knowledge of the earth at the dawn of the age of the great discoveries. As Kramers points out, in Islamic maps there are no pictures of men or animals (which is a reflection of the Islamic ban on the representation of either), which make Christian maps appear more fantastic,[2972] but far more unrealistic.

[2966] S. M. Ahmed: *A History of Arab-Islamic Geography;* op cit; p. 269.
[2967] Ibrahim Ibn Sinan: *Al-Maqala fi'l astrulab*; Ms. No 2468; Bankipur; Abu Nasr Mansur B. Ali. B. Arraq: *Al-Risala fi Sinaat al-Astrulab;* Ms. No 2468; Bankipur; in S.M.Z. Alavi: *Arab Geography;* op cit; pp. 115-6.
[2968] L. Bagrow: *History;* op cit; p. 55.
[2969] Refer to G. Sarton: *Introduction*; op cit; vol 2.
[2970] A. Mieli: *La Science Arabe;* op cit; p. 241.
[2971] See, for instance:
J. Vernet: Influencias musulmanas en el origen de la cartografia nautica, publ. *de la Real Sociedad Geografica*, serie B. No 289, 30 p (Madrid, 1953); Los conocimientos nauticos de los habitantes del occidente islamico, *extrait de la Revista general de Marina* (Madrid, June 1953), 15 p.
[2972] J.H. Kramers: Geography; op cit; p. 87.

The pioneering Islamic role in map making has only been recently recognised in one of the best works on the subject: Harley and Woodward's *History of Cartography*, a significant endeavour; of which volume two, book one is devoted to Islamic cartography.[2973] The richness of information is such that to even seek to outline the points of interest raised by the various contributors is unrealistic. Subjects vary from celestial mapping, to the history of Islamic cartography, geodesy, pre-modern Ottoman mapping, marine charting, and so on and so forth. And from the first page of the preface of this volume, one gleans a valuable comment:

> 'Even in narrative discussions of the history of cartography, such as those of Lloyd Brown and Gerald Crone, and nothwistanding the universal ring of their titles, the non European mapping traditions were largely ignored.[2974] Such an approach in the standard texts taught several generations of students that the history of cartography was largely a Western achievement and part of the history of European science. Quoting an Islamic historian of science, it was as if the descent of maps had passed 'directly from the Greco-Roman period to the European Renaissance as if nothing took place in the history of science and technology from the fall of Rome in the late 5th century to the fall of Constantinople in the fifteenth.'[2975]

Harley and Woodward have thus put their finger on the problem that this work has battled with from the first page, that is the disregard for the Islamic contribution to science and civilisation that has plagued mainstream history of science.[2976]

[2973] J.B. Harley and d. Woodward ed: *The History of Cartography*; Volume 2; Book 1; op cit.

[2974] L.A. Brown: *The Story of Maps* (Boston; Little Brown; 1949; Reprinted New York; Dover; 1979).
G. Crone: *Maps and their Makers*; 5th ed (Folkestone; Kent; Archon Books; 1978).

[2975] J.B. Harley and d. Woodward ed: *The History of Cartography*; op cit; preface; p.1.

[2976] A. Cherbonneau: *Kitab al-Filaha* of Abu Khayr al-Ichbili, in *Bulletin d'Etudes Arabes*, pp 130-44; at p. 130 speaks of the misconceptions in the study of Islamic farming; N. Smith: *A History of Dams,* op cit; p.75, refers to the same misinformation in relation to the history of dams, whilst A. Pacey: *Technology in World Civilization,* op cit; at p.8, widens the problem to the whole history of engineering. Hill insists on the same defects affecting the history of technology in D.R. Hill: Mechanical Technology, in *The Genius of Arab Civilisation; Source of Renaissance*; ed J.R. Hayes (Phaidon, Oxford, 1976), pp 175-87 at p. 175; whilst Winder stresses the neglect of Muslim mechanical engineering in R.B. Winder: Al-Jazari, in *The Genius of Arab Civilisation; op cit*; p. 188.
D. Talbot Rice: *Islamic Art* (Thames and Hudson; London; 1979) dwells on the misrepresentation of Muslim art and architecture, Turkish, most particularly. And J. J O'Connor and E. F Robertson speak of Arabic Mathematics, op cit

One key matter that has generally received no interest in the study of geography, despite its fundamental importance, is the Muslim representation of the spherical shape of the earth. Both Dreyer and Kramers have raised this issue.[2977] Kramers, for instance, states, that the Muslims had no objection to the spherical form of the earth, then denied by Christian theologians.[2978] Thus, an early Muslim geographer, Ibn Rusta (fl. 903), says:

> 'The stars which are familiar in the northern skies gradually sink lower in the heavens. The Constellation of the 'Great Bear,' which in our skies never sets, does set when sufficient southern latitude is attained, on the other hand constellations new to the inhabitants of the northern climates are seen to rise above the southern horizon. Another proof of sphericity of the earth is furnished by the fact that the moon and the stars do not rise at one and the same time in all parts of the world, as we see them rise in the east before their rise in the west, similarly their disappearance takes place earlier in the east than in the west.'[2979]

More importantly, in the world of Islam, Kramers holds, there is no record of any Muslim being persecuted for stating that the earth was a sphere, and that it was also very small compared to the size of the universe.[2980] In the Christian West, before the year 1000, Rybka points out, intellectual standards were extremely poor even amongst the supposedly well read, and this hardly encouraged the penetration of the advanced sciences of the Islamic world.[2981] At that time, in the Christian West, there prevailed the naïve idea derived from a simplistic interpretation of the Bible, that the earth could not be a sphere.[2982] This was not the case in the Muslim world, where this spherical shape was obvious in the maps the Muslims drew, and also in the globes and spheres they built. Earth is often represented in its spherical shape, most of its surface made of water, the inhabited parts constituting only a fraction of the whole surface, and deserts occupying a good place.[2983] This Islamic breakthrough, neglected today, did, however, shatter one of the most established views of the time that the earth was

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[2977] J.L.E. Dreyer: *A History of Astronomy; op cit;* p. 249.

[2978] J.H Kramers: Geography, op cit, p. 85.

[2979] Ibn Rusta: *Kitab al-Alaq al-Nafia;* ed de Goeje (Leyden; 1891), pp. 13-4.

[2980] J.H. Kramers: Geography; op cit; p. 85.

[2981] E. Rybka: Mouvement des Planetes dans l'Astronomie des Peuples de l'Islam; in *Convegno Internationale: Oriente e occidente Nel Medioevo Filosofia E Scienze;* 9-15 Aprile 1969 (Academia Nationale Dei Lincei; Roma; 1971) pp. 579-93; p. 590-1.

[2982] Ibid.

[2983] P. Lory (and H. Bellosta): Philosophes et savants; in *Etats et Societes*; op cit; pp. 371-398; at p. 382.

flat. This breakthrough opened the way in Western Christendom to the challenge of established norms, a crucial development in intellectual history. The spherical shape of the earth also raised the possibility that one end of the world could be reached by sailing in an opposite direction. The impact of this is well known. Without it, as Kramers recognises, the discovery of America would have been impossible.[2984] And this leads onto the next matter: nautical science.

4. Seafaring and Nautical Science:

It is worth beginning with some common flaws related to the history of seafaring and nautical sciences. The first flaw is the common misconception that the Muslim contribution to the subject in any form or manner is negligible because simply the Muslims feared the sea. The second relates to the common practice consisting in attributing accomplishments in the field to entities other than Muslims; mainstream history suppressing the Muslim role, and then giving many explanations for such breakthroughs, explanations which are not just different from each other but also very often fundamentally contradict each other.
The first of these two flaws can be looked at briefly; the second will get lengthier treatment under two separate headings.

With regard to the first generalised misconception, we are told that the Muslims did not contribute to maritime discoveries for the simple reason that the Muslims feared the sea. Thus, Udovitch, an otherwise much appreciated scholar by this author, says:

> 'For the pre-Ottoman Muslim policies around the Mediterranean, the sea was a menacing frontier.'[2985]

Hillenbrand devotes a good amount of space to stress this point of Muslim antipathy for, and fear of, the sea.[2986] One instance she gives to support this view is a mid 13th century (during the crusades) alleged conversation, reported by the contemporary historian, Ibn Wasil, between the captured

[2984] J. H. Kramers: Geography, op cit, p. 93.
[2985] A.L. Udovitch: An Eleventh century Islamic Treatise on the Law of the Sea; in *Annales Islamologiques*; XXVII (1993), pp. 37-54; at p, 38.
[2986] C. Hillenbrand: *The Crusades, Islamic Perspectives* (Edinburgh University Press; 1999), pp. 556 ff.

French king, St Louis (Louis IX), and the Muslim Emir Husam Eddin, who had been deputed to guard him. Husam Eddin said to his royal prisoner:[2987]

> 'How could it have come into the mind of a man as perspicacious and judicious as the king to entrust himself thus to the sea on fragile piece of wood, to launch (himself) into a Muslim country defended by numerous armies and to expose himself and his troops to an almost certain death? At these words the king smiled and said nothing. So the emir went on as follows:
> 'One of our religious scholars thinks that anyone who exposes himself and his belongings twice to the sea must be considered as mad and that his testimony can no longer be accepted in law.'
> Thereupon the king smiled again and said: 'He who said that was right'.[2988]

This story is for Hillenbrand evidence confirming the Muslim fear of the sea. This, in truth, is evidence of wanting scholarship, for a reported conversation is by no means evidence. Facts prove truth, not conversations, and facts show that the Muslims sailed to China as early as the 8th century, and that to conquer Spain from 712 onwards, the Muslims had to cross the sea, and they did so to conquer all islands of the Mediterranean (Corsica, Crete, Sicily, Majorca…), and countless more instances of the sort. Michael the Syrian, a Syriac chronicler, speaks of 5000 Muslim vessels, including supply vessels, attacking Constantinople in 717.[2989] The Aghlabid fleet, which left Sousse, in southern Tunisia, for the conquest of Sicily in 827, included 200 large ships, supported by another 300 ships coming from Muslim Spain, participating to the taking of Palermo in 830.[2990] The Umayyad fleet, which was based in Almeria and Al-Qasr (Alcacer do Sal), included 200 large ships, ready to sail for expeditions in the Mediterranean.[2991] And on top of all these fleets, always ready for sea-warfare, could be added ships engaged in civilian activities, trade, above all, which crossed the Mediterranean, from Syria to the Ebro, and also navies navigating in the Gulf, the Red Sea, and elsewhere.[2992] Thus, there was plenty of evidence to contradict this ridiculous notion of Muslim fear of the sea.

[2987] Michaud, Histoire des Croisades, IV, 449; in C. Hillenbrand: *Crusades;* p. 559.
[2988] C. Cahen: 'St. Louis et l'Islam', in Journal Asiatique; 1970, pp. 3-12; quoting Ibn Wasil, at pp. 6-7, in C. Hillenbrand; p. 559.
[2989] Edited and Translated by J.B. Chabot; II; p. 484; in M. Lombard: *Les Textiles*; op cit; p. 202.
[2990] M. Lombard: *Les Textiles*; op cit; p. 202.
[2991] Ibid.
[2992] Ibid.

Even more baffling, is when one finds Western scholarship attacking the Muslims for their fear of the sea, and the same scholarship attacking them for quite the reverse, for dominating the sea and ruining sea-trade. Pirenne and his followers, for instance, blame the decline of Europe on the fact that the Mediterranean became a Muslim lake.[2993] Much more baffling, even, is when one reads about Muslims fearing the sea, and yet causing terror on the sea, through piracy. Western literature is crammed with this Muslim piracy terrorising shipping, and devastating Christian coastlines as far as England and even beyond, beginning from the late 7th century.[2994] We read of Muslims 'infesting' the Mediterranean in the late Middle Ages.[2995] We read of them causing havoc from the 16th, through the 17th, and 18th, until the 19th century such as when Brockelmann, for instance, says:

> 'In order to bring this piratical pestilence under control, the Spaniards had attacked North Africa a number of times and had occupied the small mountainous islands lying opposite Algiers at cannon's range, from which they controlled the entry into the harbour. After the death of Ferdinand the Catholic, the Algerians, hampered in their most important vocation, summoned Aruj for help against the Spaniards….
>
> Down to the beginning of the 19th century the Beys of Tunisia and the Deys of Algiers, as well as the Qaramanlis in Tripolitania and the rulers of Morocco, had diligently pursued a career of piracy, which being directed against the Christians, was regarded by the Muslims as a meritorious war of faith.'[2996]

The mere mention of Algiers prior to the conquest by France in 1830, Earle notes, tended to create a picture of bloodthirsty pirates attacking Christian shipping.[2997] An opinion, which is still valid in historical and generalised perception to this very day.[2998]

Which causes one to ponder: how come a people so afraid of the sea, so inept at anything to do with the sea, could cause such terror on the sea for twelve centuries. One of these views, at least, does not hold truth; most certainly neither does.

[2993] H. Pirenne: *Mohammed and Charlemagne*; op cit.

[2994] See, for instance, B.M. Kreutz: *Before the Normans*; op cit; for repeated instances of early Muslim sea-borne attacks on the Mediterranean realm.

[2995] A. Cortesao: Nautical Science and the Renaissance; in *ARCHEION*; vol 2; pp. 1075-92; p. 1080.

[2996] C. Brockelmann: *History of the Islamic Peoples* (Routledge and Kegan Paul; London; 1950), p. 292; p. 397.

[2997] P. Earle: *Corsairs of Malta and Barbary* (London; 1970), p. 10.

[2998] BBC 2: Time Watch; 10 January 2003, seen by this author.

This matter having been addressed, it is now worth looking in greater detail at the second generalised weakness of mainstream history, which offers us a crowd of explanations for the modern maritime discoveries, explanations, which are deficient to their very core, and which are also contradictory with each other.

a. The Heated Battlefield of the History of Maritime Discoveries:

Western history is a true battlefield when it comes to certain decisive advances in science and civilisation. The reason being that Western historians suppress the real author of such advances, the Muslims, and then, in seeking to substitute alternative authors, each group of historians comes up with explanations, which hold no historical ground.[2999] The following highlights this matter.

A large group of historians categorically assert that Ptolemy's science was central to maritime discoveries, that between Ptolemy and the 14th century there was hardly any advance in the field, and that the only map of the Mediterranean of any worth was that of Ptolemy.[3000]

This is fundamentally wrong, the above sections on mapping, and earlier chapter on astronomy have shown how Ptolemy's maps and measurements were wrong, and that every Islamic scholar corrected his measurements. Thorndike, who has studied the matter comprehensively, rightly concludes that Ptolemy's geography:

> 'Consists largely of lists of ancient place names, many of which cannot be identified or located with any assurance and are of purely historical and linguistic interest. Moreover, Ptolemy had made the Mediterranean Sea too short[3001] by one third (Thorndike should have said too long), whereas one of the medieval portolani is more accurate than any other map of the Mediterranean until the eighteenth century. Concerning the Far East, too, and islands

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[2999] A good instance of this relates to the rise of Provencal literature and romance. See M R Menocal: *The Arabic Role in Medieval Literary History* (University of Pennsylvania Press, Philadelphia, 1987).

[3000] Commentaries following lecture by R. Almagia at the Lausanne Congres; in *Archives Internationales d'Histoire des Sciences*; vol 1; pp. 237-46, at p. 245.

[3001] Throndike is wrong, Ptolemy made it too long.

in the Atlantic, the thirteenth and fourteenth centuries were much better informed than Ptolemy. The translation and subsequent vogue of his Geography were therefore in some ways regrettable.'[3002]

Like Thorndike, a substantial group of Western scholarship is very critical of Ptolemy. Parry, for instance, says:

'In the process of Reconnaissance, explorers by sea, pushing rashly out in the world of the unknown, but for Ptolemy, and finding it bigger and more varied than they expected, began first to doubt Ptolemy, then to prove him wrong in many particulars, and finally to draw on maps and globes a new and more convincing picture. Similarly, but independently, Copernicus and his successors, studying their Ptolemy and watching the heavens, noticed certain celestial phenomena which Ptolemy's theories failed adequately to explain. They began timidly and tentatively, first, to question, then to dismantle the Aristotelian geocentric scheme of the universe, and to postulate a heliocentric system in its place. In both studies, the whole progress from deferential acceptance to doubt, from doubt to discard and replacement, took many years. Eventually in all branches of science, Reconnaissance became Revolution.'[3003]

This is a thorough refutation of Ptolemy's contribution to maritime discoveries by Parry, but his account, just like the rest of his counterparts, includes many fallacies and distortions, too. First, as this section will show below, the seas and oceans hardly remained unknown between the time of Ptolemy and the 'Renaissance' as Parry tells us. Secondly, Ptolemy as was shown in the preceding heading was amply corrected centuries before the men of the Renaissance. Had Parry also, however briefly, consulted a work by Wright, four decades earlier than his, he would have found that amongst the followers of Muslim geographers/astronomers was Raymond of Marseilles (fl 1140s). In the preamble to a set of tables for Marseilles, worked over from al-Zarqali's canons on the Toledo Tables (in 1140), we find a detailed rule for the

[3002] L. Thorndike: Renaissance or Prenaissance; in *The Making of Modern Europe*; edited by H. Asubel; Book One (The Dryden Press; New York; 1951), pp. 60-72. p.63.
[3003] J.H. Parry: *The Age of Reconnaissance;* op cit; pp. 14-5.

construction of tables for other meridians than that of Marseilles and at the places for which the tables wanted.[3004]

The material to correct Ptolemy's maps was available centuries before the Renaissance.

Furthermore, a vast knowledge of Muslim geography, in its diverse forms, had already impacted on Western Christian knowledge in the Middle and Later Middle Ages. Without going into detail, Roger Bacon (1220-1294), the author of *Opus Majus,* quoted Muslim authorities in great abundance, especially Abu M'ashar, al-Farghani, Al-Battani, Al-Zarqali, etc, and reproduced their ideas on the planetary system, ocean tides, phases of the moon, the calculation of latitudes and longitudes, and their conception of the 'Cupola of the Earth,' or Arin[3005] (the word Arin is a misreading of the Arabic transliteration of the Indian town Ujjiyaini).[3006] Cardinal Pierre d'Ailly (1410) also quotes the Arin theory in his Imago Mundi, and it was this work which inspired Christopher Columbus in his view of the shape of the earth as a pear, and so that in the western hemisphere, opposite 'the world summit,' which he located somewhere near the mouth of River Orinoco.[3007] This was one of the many ways Muslim learning impacted on the discovery of the New World, as will also be amply shown further on.

With regard to Copernicus, it has already been amply shown that his inspiration was from the 13th century Muslim astronomers such as Ibn al-Shatir of Damascus.[3008] Moreover, Copernicus studied at Cracow, and this university's learning was based on Islamic science, and authors such as Al-Battani, al-Farghani, Al-Ghazali, etc,[3009] and not on a copy of Ptolemy, which would have completely misled him (Copernicus) had he stuck by it.

Another group of 'historians' steps in, and delivers us another set of explanations for the maritime discoveries. Chaunu, for instance, says:

'All this unconscious preparation for discovery resulted with the amazing intellectual changes which took place at the end of the

[3004] Bibliotheque Nationale; Ms. Fonds Latin; n. 14704; fol 116. col c. in J.K. Wright: Notes on the Knowledge of latitudes and longitudes in the middle ages; *ISIS* 5; pp. 75-98; at p. 83.
[3005] M.S.Z. Alavi: *Arab Geography*; op cit; p. 111.
[3006] J. H. Kramers: Geography, op cit, p. 93.
[3007] M.S.Z. Alavi: *Arab Geography*; op cit; p. 111.
[3008] N. Swerdlow-O.Neugebauer: *Mathematical Astronomy in Copernicus "De revolutionibus"* (New York, Springer Verlag, 1984).
[3009] A. Brikenmajer: l'Universite de Cracovie, Centre International d'Enseignement Astronomique a la fin du moyen age. In *Studia Copernicana,* 4; 1972; pp. 483-95; or see: J.B. Korolec: La Premiere reception de la philosophie Islamique a l'Universite de Cracovie; in *The Introduction of Arabic Philosophy*; op cit; pp. 112-30.

in the Atlantic, the thirteenth and fourteenth centuries were much better informed than Ptolemy. The translation and subsequent vogue of his Geography were therefore in some ways regrettable.'[3002]

Like Thorndike, a substantial group of Western scholarship is very critical of Ptolemy. Parry, for instance, says:

'In the process of Reconnaissance, explorers by sea, pushing rashly out in the world of the unknown, but for Ptolemy, and finding it bigger and more varied than they expected, began first to doubt Ptolemy, then to prove him wrong in many particulars, and finally to draw on maps and globes a new and more convincing picture. Similarly, but independently, Copernicus and his successors, studying their Ptolemy and watching the heavens, noticed certain celestial phenomena which Ptolemy's theories failed adequately to explain. They began timidly and tentatively, first, to question, then to dismantle the Aristotelian geocentric scheme of the universe, and to postulate a heliocentric system in its place. In both studies, the whole progress from deferential acceptance to doubt, from doubt to discard and replacement, took many years. Eventually in all branches of science, Reconnaissance became Revolution.'[3003]

This is a thorough refutation of Ptolemy's contribution to maritime discoveries by Parry, but his account, just like the rest of his counterparts, includes many fallacies and distortions, too. First, as this section will show below, the seas and oceans hardly remained unknown between the time of Ptolemy and the 'Renaissance' as Parry tells us. Secondly, Ptolemy as was shown in the preceding heading was amply corrected centuries before the men of the Renaissance. Had Parry also, however briefly, consulted a work by Wright, four decades earlier than his, he would have found that amongst the followers of Muslim geographers/astronomers was Raymond of Marseilles (fl 1140s). In the preamble to a set of tables for Marseilles, worked over from al-Zarqali's canons on the Toledo Tables (in 1140), we find a detailed rule for the

[3002] L. Thorndike: Renaissance or Prenaissance; in *The Making of Modern Europe*; edited by H. Asubel; Book One (The Dryden Press; New York; 1951), pp. 60-72. p.63.
[3003] J.H. Parry: *The Age of Reconnaissance;* op cit; pp. 14-5.

construction of tables for other meridians than that of Marseilles and at the places for which the tables wanted.[3004]

The material to correct Ptolemy's maps was available centuries before the Renaissance.

Furthermore, a vast knowledge of Muslim geography, in its diverse forms, had already impacted on Western Christian knowledge in the Middle and Later Middle Ages. Without going into detail, Roger Bacon (1220-1294), the author of *Opus Majus,* quoted Muslim authorities in great abundance, especially Abu M'ashar, al-Farghani, Al-Battani, Al-Zarqali, etc, and reproduced their ideas on the planetary system, ocean tides, phases of the moon, the calculation of latitudes and longitudes, and their conception of the 'Cupola of the Earth,' or Arin[3005] (the word Arin is a misreading of the Arabic transliteration of the Indian town Ujjiyaini).[3006] Cardinal Pierre d'Ailly (1410) also quotes the Arin theory in his Imago Mundi, and it was this work which inspired Christopher Columbus in his view of the shape of the earth as a pear, and so that in the western hemisphere, opposite 'the world summit,' which he located somewhere near the mouth of River Orinoco.[3007] This was one of the many ways Muslim learning impacted on the discovery of the New World, as will also be amply shown further on.

With regard to Copernicus, it has already been amply shown that his inspiration was from the 13th century Muslim astronomers such as Ibn al-Shatir of Damascus.[3008] Moreover, Copernicus studied at Cracow, and this university's learning was based on Islamic science, and authors such as Al-Battani, al-Farghani, Al-Ghazali, etc,[3009] and not on a copy of Ptolemy, which would have completely misled him (Copernicus) had he stuck by it.

Another group of 'historians' steps in, and delivers us another set of explanations for the maritime discoveries. Chaunu, for instance, says:

'All this unconscious preparation for discovery resulted with the amazing intellectual changes which took place at the end of the

[3004] Bibliotheque Nationale; Ms. Fonds Latin; n. 14704; fol 116. col c. in J.K. Wright: Notes on the Knowledge of latitudes and longitudes in the middle ages; *ISIS* 5; pp. 75-98; at p. 83.
[3005] M.S.Z. Alavi: *Arab Geography*; op cit; p. 111.
[3006] J. H. Kramers: Geography, op cit, p. 93.
[3007] M.S.Z. Alavi: *Arab Geography*; op cit; p. 111.
[3008] N. Swerdlow-O.Neugebauer: *Mathematical Astronomy in Copernicus "De revolutionibus"* (New York, Springer Verlag, 1984).
[3009] A. Brikenmajer: l'Universite de Cracovie, Centre International d'Enseignement Astronomique a la fin du moyen age. In *Studia Copernicana,* 4; 1972; pp. 483-95; or see: J.B. Korolec: La Premiere reception de la philosophie Islamique a l'Universite de Cracovie; in *The Introduction of Arabic Philosophy*; op cit; pp. 112-30.

12th century. It followed from the rediscovery of ancient science and then its outstripping by the use of Aristotelian method.'[3010]

This is fundamentally ridiculous to say the least, for one can ask: why did neither Greece or Byzantium make the maritime discoveries Chaunu refers to if Aristotle (384-322 BC) was the key? Why, if Chaunu is talking sense did no scholar understand the earth was round by just reading Aristotle in any century (fifteen of them) that elapsed before the 12th century? What is the contribution of Aristotle to the real means which made nautical discoveries possible: portulans, sails, the compass, new methods of calculation, improved measurements and knowledge of the earth and seas, etc?

Another group of 'historians' tells us that all maritime discoveries stem from the recovery in the 12th century of Greek ship construction techniques after such techniques had been lost for over ten centuries. Casson, thus, gives 'the irrefutable proof' of Greek use of lateen sail through the evidence of a 4th century piece of mosaic which seems to show a Greek lateen rigged boat.[3011]

This point brings us, again, to the inexhaustible list of items and scientific achievements, possibly hundreds of them, lost for over ten centuries, before, by chance, all were rediscovered by miracle in the crucial 12th century, the ridiculous view held by many, not to mention the other piece of poor 'scholarship,' that a piece of mosaic could be evidence enough to build a whole theory around it.

Then we have the Portuguese group of nautical geographers who tell us that none of what the other Western historians say is right; that instead, maritime discoveries are owed to Portugal, and to one man, in particular, Henry the Navigator, the father of modern nautical sciences. Hence, Cortesao writes:

> 'The Portuguese were the designers and founders of nautical science in the 15th century, and until the first quarter of the 16th century they were unrivalled by any other people in its development and progress. From other people they received, however, the scientific preparation which constituted the

[3010] P. Chaunu: *European Expansion in the Later Middle Ages;* tr. by K. Bertram (North Holland Publishing Company; Amsterdam; 1979), pp 84-5.
[3011] L. Casson: *Ships and Seamanship in the Ancient World* (Princeton; 1971); p. 244; and fig .182.

> background of their performance. Their merit lay above all in the fact of giving a practical application to a branch of scientific knowledge (astronomy, use of the astrolabe..) that had been used for speculative purposes only, thus solving a problem on the solution of which depended the progress of mankind. With the foundation of nautical science- a first step only in the great age of discovery of which they were the leading artisans-the Portuguese came to play a leading role in the Renaissance.'[3012]

To reinforce one of his principal arguments, the Portuguese use of instruments for practical purposes, Cortesao quotes a Spanish pilot of the early 17th century:

> 'Spaniards, French, English and Dutch owe what they know to the Portuguese, who taught them how to navigate on the high seas and in distant regions: to them not only Spain, but the whole of Europe owes the application of the astrolabe, which the ancient always used in order to know the movement of stars, to the use of art of navigation-such a great invention as its consequences show.'[3013]

Cortesao and the Portuguese 'school' are very much nearer the truth than any other group of scholars with regard to nautical discoveries. And so are the Spaniards, who also insist on the role of the Iberian Peninsula in such discoveries, and, facts prove their case. Both Portugal and Spain played the leading role in maritime discoveries, for it was they who discovered the Americas, the route round Africa, the route to India, and so on and so forth. Where one disagrees with this Iberian school is when they bypass, except by vague remarks, the role of those who preceded them in setting up the foundations for Spanish and Portuguese discoveries, or when they make historically false statements as follows.

Cortesao, for instance, after reminding of one of the usual myths: 'Arab pirates from the North African coast growing more daring, infesting the Mediterranean, keeping navigation in these waters at their mercy,'[3014] adds:

> 'Arab geographers had spread the legend that beyond Cape Bojador (26^0 6'N) there was the Sea of Darkness and that torrid zone which would turn black any man who dared to penetrate into it. When the Portuguese (of course) doubled Cape Bojador in

[3012] A. Cortesao: Nautical Science and the Renaissance; in *ARCHEION*; vol 2; pp. 1075-92; at p. 1077.
[3013] Thome Cano in *Arte para fabricar, fortificar y apareiar naos de Guerra y mercantes*.... (Seville, 1611), in A. Cortesao: nautical Science; p. 1088.
[3014] A. Cortesao: Nautical; p. 1080.

1435 and reached Garnet Bay (24^0 51'N,) they not only dispelled a centuries old legend of terror but opened a new age in the history of navigation.'[3015]

Of course Cortesao makes wild statements without providing any source for either of his assertions, just as he fails to do for others. Generalisations which are not backed by historical reality, either. Had Cortesao explored the history of his country, he would have read of those 'Arab' sailors who departed from his own capital, Lisbon, when it was in Muslim hands, in the 9th century, in the direction of unknown lands and, rather than telling of men turning black, instead, provided good descriptions of lands, including of the Canaries Islands, which the Portuguese were to only discover for themselves centuries after Muslim sailors had already described them.[3016]

Cortesao also makes a serious mistake, when he says:

'The Muslims used astronomical observations for astrology, and it was specifically for this purpose that it passed into Spain and Portugal… There is no reason to assert, as some have done, that any goniometric instrument was used to determine latitudes at sea before the second quarter of the 15th century. Certainly not in Europe. It is true that when Vasco da Gama arrived in the Indian Ocean he found that the Arab pilots could determine the astronomical latitude at sea by means of a rudimentary apparatus of their own; but the process was inferior to that used by the Portuguese, we do not know when it began, and it never spread to Europe.'[3017]

Again, he is not backing his statements by references, making generalised assertions, which do not hold scientifically. And he is also wrong on many accounts. First, how can Cortesao be sure instruments were 'never' used at sea in Europe before the Portuguese? How can he be sure the Muslim techniques of navigation in the East 'never' spread West?[3018] Cortesao would have to be the greatest reader of the past, to make such assertive statements, and not to back them with any evidence. Secondly, had Cortesao enquired just a little on Muslim sciences and civilisation, he would have found that processes found East were also common West, with variations, of course, but knowledge was shared East and West of the Islamic realm in respect to nearly every matter, learning, technology, construction, arts, gardening, farming, trade, etc. Pilgrimage, travels of

[3015] Ibid.
[3016] See summary of these voyages of discovery in D.M. Dunlop: *Arab Civilisation; op cit;* pp.160 ff.
[3017] A. Cortesao: Nautical; p. 1084.
[3018] Ibid; p. 1085.

sailors, traders, scholars, exchanges of diverse sorts, through caravans, diplomatic and political channels, teaching, etc, all united the Islamic world in a common heritage.[3019] Moreover, when Cortesao says that the astrolabe was passed by the Muslims to Spain and Portugal for astrological purposes only,[3020] he tells a fallacy. Had he explored the usage of the astrolabe by the Muslims, he would have found it included countless uses for the solution of practical problems.[3021] Had he looked at the 10th century Spanish Catalan use of the astrolabe, inherited from the Muslims, for instance, he would have found it was used in practical matters such as land surveying. The 10th century *Geometria incertiauctoris*, which Millás Vallicrosa relates to the Arabized scientific corpus of the Monastery of Ripoll (in Catalonia),[3022] details a variety of triangulation procedures that can be effected with the astrolabe, including the measuring of height and distance by right-angled triangles and squares.[3023] The astrolabe was used in astronomy, of course, but also in navigation.[3024] And had Cortesao read history properly, he would have come to the single conclusion: the Muslims did not need to pass the uses of the astrolabe to either the Portuguese or the Spaniards: the Muslims were part and parcel of the history of these countries, and their legacy, including of the use of the astrolabe, astronomical learning, etc, was just assimilated alongside the rest of the Islamic heritage. Among those who inherited such learning was Alfonso the Wise (King of Castile 1252 to 1284), whose *Liber del saber Astronomica,* as Cortesao fails to say,[3025] was based on al-Zarqali,[3026] and that Al-Sufi, who wrote on astrolabe uses, was also the source of the Alfonsine tables.[3027] Moreover, Denis of Portugal (1261-1325) was by no means as innovative as he (Cortesao)

[3019] See, for instance, G. Sarton: *Introduction*; op cit, on the countless instances of shared knowledge between the Muslim East and West.
[3020] A. Cortesao: Nautical; op cit; p. 1085.
[3021] H.N. Saunders: *The Astrolabe*; op cit; p.7. W. Hartner, ''The Principle and use of the astrolabe," op cit; and J.D. North: ''The Astrolabe," op cit.
[3022] In T. Glick: *Islamic and Christian Spain*; op cit; p. 228.
[3023] Ibid.
[3024] See: W. Hartner, 'The Principle; op cit; pp. 287-318; and J. D. North: ''The Astrolabe," op cit; pp 96-106.
[3025] A. Cortesao: Nautical; op cit; p. 1086.
[3026] W. Hartner, "Asturlâb," *Encyclopaedia of Islam*; New series; I: 722-8; J. Millás Vallicrosa: "Introducción del cuadrante con cursor"; M. Destombes, "Diffusion des instruments scientifiques," pp. 36-38, 41; Salvador García Franco, Catálogo crítico de astrolabios existentes en España (Madrid: C.S.I.C., 1945); etc.. all in T. Glick: *Islamic*, op cit; p. 267.
[3027] H.J.J. Winter: Notes on al Kitab Suwar al-Kawakib (of al-Sufi); in *ARCHEION*; Vol 8; pp. 126-33; esp. pp. 130-1.

implies,[3028] but was an adept of Islamic learning, Denis 'doing for his country what Alfonso the Wise had done for his own a little earlier.'[3029] As for the idea of using instruments for determining latitudes at sea, it did not come naturally to the mind of Prince Henry's cosmographers, [3030] but had come to Muslim minds earlier than theirs.[3031] Cartography did not develop pari passu with Portuguese navigation, either, as Cortesao says, speaking of 'ample evidence' to prove his point, without citing such evidence,[3032] but contrary to what he says, and as the previous heading has shown, cartography developed centuries before the Portuguese amongst Muslims. Just as nearly every aspect of nautical science is owed to the Muslims as is now shown.

b. The Islamic Role in Nautical Discoveries: Reassessing Mainstream Modern History:

Contrary to what most historians dealing with maritime discoveries hold, nautical science, like every other scientific accomplishment and manifestation, did not die or disappear for nearly fifteen centuries to suddenly re-appear in the 12th century, through the rediscovery of Ptolemy, or Aristotle, or to reappear in the later Renaissance (16th century) thanks to the Iberians. As Dunlop correctly points out:

> 'The Arab empire at its greatest expansion in Umayyad and early 'Abbasid times (8th century) extended from Spain in the West to China in the East, and in round terms this is the fact, but perhaps the extraordinary outward thrust of the Arabs in the seventh century is conveyed best to the imagination by emphasizing the maritime activity of the same nation at the same time off the Atlantic and Pacific coasts of Eurasia. This was a phenomenon which had scarcely as yet been seen, and pointed forward to the achievements of the great colonial empires of modern Europe.'[3033]

[3028] A. Cortesao: Nautical; op cit; p. 1086.
[3029] G. Sarton: *Introduction*; Volume III; op cit; p.61.
[3030] A. Cortesao: Nautical; op cit; p. 1086.
[3031] Refer to following heading; see also, M. Destombes criticism of G. Baujouan; E. Poulle: Les Origines de la navigation astronomique au 14 em et 15em siecle; in Le Navire et l'Economie maritime du 15em au 18em siecles; Paris; 1957. Rev by M. Destombes; *ARCHEION;* 13; pp. 144-5. at p. 144.
[3032] A. Cortesao: Nautical; op cit; p. 1087.
[3033] D.M. Dunlop: *Arab Civilisation*; op cit; p.160.

Centuries, indeed, before Western Christendom, Muslim ships crisscrossed the seas in, and surrounding, that vast empire, reaching parts and distances never reached by their Western counterparts, and in doing so, bequeathed not just new practical knowledge of the art, but also an abundance of original written material of varying sorts, which formed the foundations of the maritime discoveries of the modern era.

Early sea travels by the Muslims are abundant in density and diversity, and they had a wide reach all over the continents. The sailing trips to China, South East Asia, the African coastline, in and out of the Arab Peninsula, in and out of Alexandria, or in and out of Andalusia and Muslim Spain have been abundantly seen (above and in part one) and do not warrant detailed repetition here. Briefly, Muslims had, in earnest, explored the area between Ceylon (Sarandib) and the west coast of India.[3034] Ships sailed between the Arab peninsula west to the east coast of Africa (the fief of Oman), with its 37 ports located in modern Kenya, Mozambique and Tanzania, and east in direction of the Sultanate of Delhi.[3035] In 1420, a Muslim ship went round the Cape, and entered the Atlantic, which was about sixty eight years before the Portuguese reached the Cape.[3036] Atlantic sailing had, in fact, begun much earlier according to an account by al-Idrisi. He tells of a voyage of a group of Muslim sailors called *al-Mugharirrun* (the Adventurers) of Lisbon into unknown lands in the 9th century.[3037] Guided by favourable winds, they reached as far as the Polar Regions, and possibly knew of a land beyond the Atlantic Ocean.[3038] A Muslim party had also sailed to Scandinavia, to the Viking court around the middle of the 9th century, and more did so thereafter as already seen above. Muslims also knew of the British Isles (twelve in numbers according to al-Battani with Inkiltara (England), Squsia (Scotland) and Irlanda (Ireland).[3039] They described whaling in the vicinity of Ireland[3040] and seal fishing in the Atlantic Ocean.[3041] To the south of Spain, they

[3034] J.H. Kramers: Geography, op cit, p. 95.
[3035] Henri Grosset-Grange: Arabic, op cit, p 203.
[3036] Ibid.
[3037] Abrege par Gabriel Sionite, *Geographia Nubiensis* (Paris, 1619), p. 157, in Baron Carra de Vaux: *Les Penseurs,* op cit, pp. 47-9.
[3038] M. A Kettani: Science, op cit, p. 82.
[3039] C. Nallino: *Al-Battani sive Albatenii Opus Astronomicum* (Milan, 1903), Arabic text, 26; Latin tr. 18. in D.M. Dunlop: *Arab Civilisation,* op cit, at p. 160.
[3040] Qazwini, ed. Wustenfeld, ii, 388; Eng. tr. in D. M. Dunlop. 'The British Isles According to Medieval Arabic Authors', *Islamic Quarterly*, iv (1957), pp 11-28 at pp 19-20.
[3041] Al-Maqqari: *Nafh-al-tib*, ed Leiden, i, 121-2; in D.M. Dunlop: *Arab Civilisation*, op cit, p. 162.

reached the Canaries and the Cape Verde Islands centuries before their immediate successors the Portuguese.[3042]

This sea and ocean going opened the way to a vast, and early, scientific knowledge of matters related to navigation. Abu Ma'shar (d. 886), for instance, shows a knowledge of the monsoons of the Gulf and the seas of India, and he writes about the causes of the ocean tides and currents.[3043] This knowledge was of great importance to the navigators of his day, and he was prolifically quoted by Roger Bacon in his *Opus Majus.*[3044]
Likewise, in his travels to China, Suleiman (9th century), was able to make a remarkable observation, that the seas of India, Persia, and the Mediterranean form a block of water. He says:

> 'Among the things that have happened in our days, and were not known were these: It was not conjectured that the Chinese Sea and the Indian Ocean were not connected with the Syrian sea, nor had the sailors of bygone days any such idea. But this was proved in our time. For we received a report that the timbers of ships wrecked in the Mediterranean Sea, and shattered into pieces by the waves, were carried into the Khazar Sea by the wind and from there came to the Mediterranean Gulf, and after that to the Mediterranean and Syrian Seas. This proves that the Sea lies round China, Seuila at the back of Turkestan and Khazar, and then drifting into the Mediterranean Gulf flows to the Syrian coast.'[3045]

Al-Yaqubi, too, notes in his description of the Moroccan coastal town of Sos:

> 'In front of this Mosque (Bahlol), the sea brings forth those rope fastened ships, which are built in Obulla (Gulf) and in which they voyage to China.'[3046]

This matter is further studied by Al-Biruni, Abu Hamid of Grenada, Abu'l Fida, Ibn Khaldun etc.[3047] Its impact, other than the noted fact of the seas being interconnected was that:
a.) It opened a completely new vision of the shape of the world, and that stirred a renewed spirit of enquiry, in places shattering hitherto accepted wisdom.

[3042] In S. Nadvi: *Arab Navigation*, op cit, pp 87-8.
[3043] Abu Ma'shar: *Al-Madkhal al-Kabir;* Ms. No A. 1504; Arabic Society Library; Calcutta; fol 62.
[3044] S.M. Z. Alavi: *Arab Geography*; op cit; pp. 21-2.
[3045] S. Nadvi: *Arab Navigation*; op cit; pp 74-5.
[3046] Ibid; p. 76.
[3047] Ibid; pp 76-84.

b.) It also brought forth the idea that, once various parts of the earth were linked by water, sailing east could take one to a point in the west; and vice versa. The implications of this are well known.

As early as the 10th century, Muslim sailors and learned men such as al-Biruni, had also acquired an excellent knowledge of two major sea and ocean routes.[3048] One route led them from the Arabian Sea to the Chinese Sea, then to the North Pacific Ocean; entering the Bering Sea, out through the Arctic Ocean, into the Atlantic, through Gibraltar into the Mediterranean. The second went from the Indian Ocean to the Abyssinian Sea, down through the Mozambique Channel, to the Cape of Good Hope, passing by the African coast, to the Atlantic Ocean via the Cape of Gibraltar, and then entered the Mediterranean Sea.[3049]

A crucial development arose from this sea and ocean going, and relates to the pioneering findings of al-Biruni. Until his time, the overall concept that prevailed was of an unknown land connected with South Africa, but al-Biruni put forward the concept of the existence of a sea passage between south Africa and the unknown land.[3050] Abul'l Fida (1273-1331) incorporated this concept in his *Taqwim al-Buldan,* and it is possible that the Portuguese navigators and explorers of the later period may have had the idea of an entrance to the Indian ocean from the work of Abu'l Fida, which might have reached Tangiers about this time.[3051]
It is also established, through Frau Mauro, who drew a world map in 1457, that an Arab navigator had, in 1420, sailed from the Indian ocean into the Atlantic, around the Cape of Good Hope.[3052] The great world map completed at Venice in 1459 by Fra Mauro, with Bianco's assistance, appears to give little more information for West Africa. East Africa is represented in some details, perhaps from Islamic sources, and Fra Mauro explicitly repudiates the Ptolemaic concept of a land locked Indian Ocean, showing an open seaway round the southern point of Africa.[3053]

There was a further Islamic impetus to nautical advance in the use by Islamic sailors of instruments for navigation purposes. According to Ibn Majid, the *mu'allims*, the master pilots famous in the 10th century under the

[3048] Ibid, pp 87-8.
[3049] Ibid.
[3050] S.M. Ahmad: *History*; op cit; pp. 236-7.
[3051] Ibid.
[3052] I.J. Krckovskij: *Izbrannye Socinenja,*. Op cit; p. 5 62.
[3053] L. Bagrow: *History;* op cit; p. 105.

Abbasids, used the astrolabe in their seafaring expeditions.[3054] The portable astrolabe was used by navigators for measuring altitudes until the 17th century, whilst the *ruba* was used for measuring the angles.[3055] The compass, which most certainly was a Chinese invention, was turned by the Muslims into an essential element of navigation,[3056] used for finding direction.[3057] In respect to the latter, Nadvi reminds us how as early as the 9th century, Muslim sailors of the Arabian sea referred to the *dai'ra* (circle) and to the *beit of al-ibra'a* (Abode of the Needle.)[3058] The sundial was used for calculating daily time and the azimuth (compass bearing).[3059]

Early on, Muslims pioneered in the adaptation of exact sciences to navigational purposes. This includes precise surveys of the oceans, steering ships clear of gales and storms, familiarity with the direction of winds, great knowledge of nautical astronomy, especially as, among the navigators were many astronomers and mathematicians who prepared sea charts, and who calculated the length and breadth of the oceans.[3060] This science also includes first-rate representations of the coastlines, as of the Indian Ocean by Ibn-Majid and al-Mahri.[3061] Ibn Majid, according to Portuguese sources, was in possession of a very good sea map and other maritime instruments.[3062]

The portulan (nautical chart) was crucial to the progress of navigation, helping the pilot find with extreme accuracy the ship position, and determine precisely the direction to follow to reach a determined point.[3063] The origin of portulans is dated by Saunier Site at between the late 11th and early 12th century, the work of al-Idrisi at the Norman Court.[3064] Miquel, however, dates them to the end of the 9th century.[3065] Grosset-Grange, for his part, holds they were not much in use in the earlier stages

[3054] In Carra de Vaux: *Les Penseurs;* op cit; p.67.
[3055] A. Buang: Geography in the Islamic world; in *Encyclopaedia* (Selin ed): pp 354-6: at p.356:
[3056] W. M. Watt: *The Influence,* op cit, pp 20-1.
[3057] A. Buang: Geography in the Islamic world; op cit; at p.356:
[3058] S. Nadvi: *Arab*; op cit; p.111.
[3059] A. Buang: Geography in the Islamic world; op cit; at p.356:
[3060] S.M.Z Alavi: *Arab Geography*, op cit, p. 52.
[3061] Henry Grosset Grange: Arabic, op cit, p. 221.
[3062] J.H. Kramers: Geography, op cit, p. 96.
[3063] A.Teixeira da Mota: Methodes de navigation et cartographie nautique dans l'Ocean Indien avant le XVI siecle.in *The Global Opportunity*; ed by F.F.Armesto (Variorum; Ashgate Publishing; London; 1995), pp. 44-91, at p. 56.
[3064] A. Saunier Seite: De la Geographie Grecque a la Cartographie occidentale du XVII siecle; *Acta Geographica*; No 101 (1995); pp 3-18; at p. 7
[3065] A. Miquel: Geography, op cit, p. 811.

of navigation, but adds that although such Muslim charts are lost, the Portuguese did see them.[3066] Kimble points out that the supposition that there may have been Muslim charts in earlier centuries is not entirely without foundation, for Marco Polo confesses that he drew his knowledge of the coast of Ceylon from the 'charts of the mariners of those seas.'[3067] And Ramon Lull, writing about the same time, refers to the practice of sailors carrying chart and compass.[3068] From Muslim sources, we learn that there were already in the early 11th century professional writers of nautical instructions. The earliest dated pilots were Ahmed Tabruya, and Al-Arki (the latter sailing on an Indian ship in the year 1009-10), who wrote on navigation, and whose works were used by subsequent master pilots.[3069] Sahl Ibn Aban, Mohammed Ibn Shadban, and Laith Ibn Kahlan to name only three, were also writers on the subject, and the date for these three, according to Tibbetts, could be the end of the 11th or early 12th century.[3070] Al-Muqaddasi (10th century)[3071] also claims to have seen a paper map in the library of the Samanid ruler of Khorassan, and another in Nishapur, and in two other libraries. Each was different from the other. He says:

> 'I have wandered on the Arabian coast from the Mediterranean to Abadan, besides those islands where ships stopped to take water. I have met those old mariners, who were born and brought up in this sea. They were skippers, passenger stewards, mathematicians, agents or merchants. Their knowledge of the seas, harbours, winds and islands was more reliable than those of any other men, so I asked them of the sea and its boundaries, and argued with them. They had a large number of files and books, on which they relied, and they act according to the directions given in them. I copied many things from them and compared their maps with mine.'[3072]

The Islamic impact in respect to portulans is obvious, and subsequent charts developed in Europe had Islamic sources.[3073] The Genoese, for instance, used earlier Muslim treatises of Ibn Hawqal and al-Bakri to devise their portulans.[3074] As De la Ronciere explains, the Genoese

[3066] H Grosset-Grange: Arabic Nautical Science, op cit; p. 220.
[3067] The Book of Ser Marco Polo; vol; 2; pp. 312-3 in G.H. T. Kimble: *Geography in the Middle Ages;* op cit; p. 190.
[3068] Vide Arbor Scientific (written 1300) (Lyon edition 1515), fol cxci.
[3069] G.R. Tibbetts: Arab Navigation in the Indian Ocean; op cit; p. 2.
[3070] G.R. Tibbetts: Arab Navigation; pp. 4-5; and G. Sarton: *Introduction*; vol ii; p. 221.
[3071] Al-Muqaddasi: *Ahsan at-taqasim; op cit.*
[3072] Ibid; p. 10.
[3073] W. M. Watt: *The Influence*, op cit, p 21.
[3074] J.H. Kramers: Geography, op cit, p. 98.

learned the arts of navigation from the Sicilians in the early 13th century and transmitted them subsequently to the Spaniards, Portuguese, French, and English; and a new science of the seas was developed upon the foundations originally laid by Sicilian Muslims and Normans.[3075] De la Ronciere concludes that the use of coastal charts was destined to become general in Sicily, a rational method of navigation to be substituted for the routine of pilotage, and thus the way was prepared for the progressive conquest of the world.[3076]

Much knowledge relating to the Indian Ocean was also derived from Islamic nautical treatises.[3077] Carra de Vaux points to the modern studies by Ferrand and Demombynes on nautical instructions left by Muslim pilots at the end of the 15th century.[3078] The instructions, de Vaux notes, served as a basis to those of the Portuguese pilots of the following century. They are, he says, in prose and in verses, and can be found in Arab manuscripts of the French National Librarie (Bibliotheque Nationale).[3079] The two main authors of such manuscripts are Ibn Majid (the author of more than thirty nautical treatises, according to Miquel)[3080] and Suleiman al-Mahri. They were the result of the two men's first hand ocean experience.

Ibn Majid (d. early 16th century) belongs to a family of navigators from Oman, both his father and grandfather being mu'allims (masters of navigation,) and he, himself, sailed most of his life on the Indian Ocean, its gulfs, and the Red Sea, gathering experience and knowledge of navigation, both in theory and practice, his works were to serve as guides to future navigators in the Indian Ocean.[3081] Ibn Majid did not just rely on his experience, but also on earlier works on the subject, including those by the famed three mu'allims of the Abbasid period, Mohammed b. Shadhan,

[3075] De La Ronciere: Marine Francaise; vol 1; 1909; p. 136-7 in J.K. Wright: *The Geographical Lore of the Time of the Crusades* (Dover Publications; New York), 1925; p. 81

[3076] Ibid.

[3077] C. de Vaux: *Les Penseurs de l'Islam*, op cit, chapter ii, pp. 41-74;

[3078] The outline of the publication includes four volumes; the first two include the reproduction of the nautical instructions of Ibn Majid and Soleiman al-Mahri. The third includes the translation of the reproduced geographical parts of the manuscripts and a glossary of nautical expressions. Part IV is the translations of some ancient Portuguese seafarers. 'From the comparisons of these seafarers with previous Arab texts, the document says, it comes out that these have been established after Arab originals."

[3079] C. de Vaux: *Les Penseurs de l'Islam*, op cit, chapter ii, pp. 41-74;

[3080] A. Miquel: Geography, op cit, p. 811.

[3081] S.M. Ahmad: *History;* op cit; p. 234.

Sahl b. Aban. And Layth b. Kahlan.[3082] He produced a number of works on the subject, including his *Kitab al-Fawaid fi usul ilm al-bahr* (Treatise on Nautical Sciences), dated 1489-90.[3083] He gives useful information on the principles of nautical science, and also describes the large islands such as Madagascar, Java, Sumatra, Ceylon, etc.[3084] In this work, Ibn Majid also describes the sea coasts of the then known world (Asia, Europe and Africa) which no other geographer, with the exception of Al-Biruni, to some extent, did before him.[3085] Ibn Majid is also the author of *al-hawi* (the Compodium), dated 1462, which discusses wind directions, sea routes, coastal roads of Arabia and other places, distances between ports, latitudes of ports on the Indian Ocean and so on.

Suleiman al-Mahri is a younger contemporary of Ibn Majid, who flourished early in the 16th century, and who is the author of five works on navigation, preserved in a manuscript of the Bibliotheque Nationale Paris (MS. No 2559).[3086] His largest work is *al-Umdat al-Mahriya fi dabt al-Ulum al-Bahriya*, written in 1511, a treatise that includes fifty folios, and seven chapters dealing with: 1.Principles of nautical astronomy; 2. The stars and navigation; 3 and 4. Sea Routes; 5. *Qisayat*; 6. On Seasonal Winds; 7. On the Red Sea. It includes subjects related to names of stars, sea routes, islands and how to reach them; latitudes of places from observation of the polar star; monsoons; itineraries along the African coast; the seas of Western China and Indonesia, etc.[3087] His second large work is *Kitab Minhaj al-Fakhir fi ilm al-Bahr*, also in seven chapters, included coastal regions of the Indian Ocean; ports; large islands; distances between Arab countries, the coastal regions of India, winds, storms, signs of land, and in conclusion, the five sea-routes.[3088]

Whilst sojourning in the Gulf in 1553, the Turkish admiral, Sidi Ali Tchaleby gathered Arab writings on nautical instructions, and had them translated into Turkish in a treatise entitled '*The Mohit*, and what surrounds it'.[3089] The *Mohit* is divided into an introduction and nine

[3082] Ibid.

[3083] Ibn Majid: *Kitab al-Fawaid*; published by I. Khuri and I. Hasan (Damascus; 1971); English translation by G. Tibbetts: *Arab Navigation in the Indian Ocean before the Coming of the Portuguese* (London; 1971).

[3084] Carra de Vaux: *Les Penseurs;* op cit; pp 72-4.

[3085] S.M. Ahmad: *History;* op cit; p. 234.

[3086] I.J. Krckovskij: *Izbrannye Socinenja,*. op cit; pp. 630-1.

[3087] Ibid.

[3088] Ibid. See also S.M. Ahmad: *History*; op cit; pp. 246-7.

[3089] Hammer Purgastall: extracts from the *Mohit*, that is the Ocean, a Turkish work on navigation in the Indian seas, in *Journal of Asiatic Soc of Bengal*, vols iii to viii (1834 to 1838).

chapters, including subjects such as the distance of the stars and their altitudes, the calculation of time, calendars of different nations, division of the needle box, sea routes, terminology of the art used by sailors, seasonal winds, dangers that might accrue to sailors, and also the New World (i.e America).[3090]

Islamic superior seafaring is further demonstrated by the fact that in the 14th century, some of the officials responsible for the Chinese navy were Muslims, notably the famed admiral Zheng He (Cheng Ho), whose father had even been on pilgrimage to Makkah.[3091] The Portuguese, too, had large recourse to Muslim pilots, as can be amply shown in chronicles and other governmental sources.[3092] Gaspar Correia, for instance, asserts that following his first trip East, Vasco de Gama brought back to Portugal Muslim pilots, whom he lodged in his own house, and to whom he had recourse for the preparations of the fleet of Cabral.[3093] Albuquerque's commentaries also make many references to the widespread use of Muslim pilots, generally those embarked in 1507 at Melinde, Socotora, and Orfacao.[3094]

Portugal was no China, though; and, as to be seen in the final chapter of this work, Ibn Majid guiding in 1498 the Portuguese fleet to Calicut in India (in present Kerala state),[3095] was going to be very costly for the Muslims, destroying their supremacy in the region. Arab sources of the time state that he was induced to show the way to the Portuguese only after having been made drunk.[3096]

Finally, Columbus' discovery of the New World is owed to earlier contribution by Islamic nautical science as noted by Kramers.[3097] Kramers explains that the discovery owes much to the idea that the known hemisphere of the world had a centre or 'world summit' which was equally distant from east, west, north, and south, referred to by Al-Battani as the 'cupola of the earth' (*Qubbat al Ard* in its Arabic original), whilst

See in the same collection J. Prinseps: *Note on the Nautical Instruments of the Arabs*, vol ii, 1836.

[3090] I.J. Krckovskij: *Izbrannye Socinenja,*. op cit; pp. 635 ff. See also S.M. Ahmad: *History*; op cit; pp. 248-50.

[3091] A. Pacey: *Technology;* op cit; p.55.

[3092] T.A.da Mota: Methodes; op cit; p. 52.

[3093] G. Correia: Lendas da India; Lisboa; 1858-1866; Vol 1; part 1; Gama ch xxii; Cabral Ch 1; in T. A da Mota: Methodes; op cit; p. 52.

[3094] In T.A.da Mota: Methodes; op cit; p. 52.

[3095] Henri Grosset-Grange: Arabic, op cit, p 203.

[3096] J.H. Kramers: Geography, op cit, p. 96.

[3097] Ibid; pp. 93-4.

Ibn Rusta refers to it as the 'cupola of Arin'. The word Arin itself is a misreading of the Arabic transliteration of the name of an Indian town. Adelard of Bath, Gerard of Cremonna, Roger Bacon and Albertus Magnus, considered this Arin theory of the highest importance, which was later to be found in the *Imago Mundi* of Cardinal Peter of Ailly published in 1410. From this book Christopher Columbus learnt the same doctrine, to believe that the earth had the shape of a pear, and that, on the western hemisphere, opposite the summit of Arin, was another centre, much higher than the one on the eastern side, thus forming the shape of the lower half of a pear. This induced him in his sailing experience when all around him was against it. What followed his successful attempt is well known.

This chapter has abundantly shown the vast and pioneering Islamic role in nautical science and seafaring. Yet, this is what Hartmann, expressing a widely established view, writes:

> 'Islam has as a rule been afraid of the sea; from the very beginning it was impressed with a sense of the supremacy of the unbelievers on the Ocean and made practically no efforts to dispute their domination.'[3098]

[3098] M.Hartmann: China; *Encyclopaedia of Islam*; 1st series; Vol 1 (Brill; Leiden; 1913), pp. 839-54; at p. 844.

MATHEMATICS

Of all Islamic sciences, mathematics has been best served by scholarship, most particularly in the recent decades.[3099] Kennedy offers a good survey of the mathematical sciences in Islam.[3100] Yet despite this, its due place is not adequately recognised, and only a work of vast proportions, a sort of encyclopaedia of Islamic mathematics, written by those who excel at mathematics, Arabic, Islamic history, and the history of mathematics, could do it justice. Muslim mathematics, like other sciences, has also been a victim of the usual historical distortions, which misattribute, or suppress many of its accomplishments, or demean its importance. The following outline aims at raising some such problems. However, as with all other issues addressed in this work, this author does not have the competence, nor the space, to address all matters as adequately as wished. Others in the future will have to pursue the task.

[3099] See for instance:
-J.L. Berggren: History of Mathematics in the Islamic World: The Present State of the Art. *Middle East Studies Association Bulletin* 19(1985), pp. 9-33.
-J.L.Berggren: Mathematics and Her Sisters in Medieval Islam: A Selective Review of Work Done from 1985 to 1995. *Historia Mathematica* 24 (1997), pp. 407-40.
-J.L. Berggren: *Episodes in the Mathematics of Medieval Islam* (Springer, 1986).
-K.Jaouiche: *La Théorie des parallèles en pays d'Islam* (Paris;Vrin, 1986).
-D. Lamrabet: *Introduction à l'histoire des mathématiques maghrébines* (Rabat, 1994).
-R. Lorch: *Arabic Mathematical Science* (Variorum, Aldershot, 1995).
-R.Rashed: *Les Mathématiques infinitésimales du IXe au XIe siècles.* 2 vols (Al-Furqan; London; 1993-96).
-R.Rashed: *Géométrie et Dioptrique au Xe siècle: Ibn Sahl, al-Quhi et Ibn al-Haytham* (Paris: Les Belles Lettres, 1993).
-B. Rosenfeld and G.P.Matvievskaya: *Matematiki i astronomi musulmanskogo srednevekovya i ikh trudi* (VII-XVII vv), 3 vols (Moscow: Nauk, 1983).
-F. Sezgin: *Geschichte des arabischen Schrifttums* (Leiden: E.J. Brill, 1967-).
-H. Suter: *Die Mathematiker und Astronomen der Araber*; op cit;
-F.Woepcke: Traduction du traité d'arithmétique d'Aboul Haçan Ali Ben Mohammad Alkalçadi. *Atti dell'Accademia Pontificia dei Nuovi Lincei* 12 (1858-9), pp. 230-75.
-A. Youschkevitch: *Les Mathématiques arabes* (VIIe-XVe siècles), (Paris: J. Vrin, 1976).
-S.Zeki: *A History of Arabic Mathematics*: 2 Vols (Istanbul, 1929).

[3100] E.S. Kennedy: The Arabic Heritage in the Exact Sciences; *Al-Abhath*; vol 23; pp. 327-44.
E.S. Kennedy et al: *Studies in the Islamic Exact Sciences*; The American University of Beirut; (University of Beirut Press, 1983).

1. General Observations:

First and foremost, it is important to consider again the issue of the true scale of the Greek legacy on Islamic mathematics. The Greek legacy is decisive in one area, geometry, but is minimal or non-existent in others. It is, however, common for many historians of sciences to widen the impact in one area (geometry) to the whole science of mathematics (just as Islamic mapping relying on aspects of Greek mapping is turned into plagiarism of Greek geography by Muslims). A worse error, however, is the widely held view that nothing happened in the medieval period. O'Connor and Robertson comment on this:

> 'There is a widely held view that, after a brilliant period for mathematics when the Greeks laid the foundations for modern mathematics, there was a period of stagnation before the Europeans took over where the Greeks left off at the beginning of the sixteenth century. The common perception of the period of 1000 years or so between the ancient Greeks and the European Renaissance is that little happened in the world of mathematics except that some Arabic translations of Greek texts were made which preserved the Greek learning so that it was available to the Europeans at the beginning of the sixteenth century.'

The authors go on saying:

> 'That such views should be generally held is of no surprise. Many leading historians of mathematics have contributed to the perception by either omitting any mention of Arabic/Islamic mathematics in the historical development of the subject or with statements such as that made by Duhem that: 'Arabic science only reproduced the teachings received from Greek science.'[3101]

Rashed also notes how it has been frequently affirmed since Condorcet and Montucla up to Borbaki, by way of Nesselman, Zeuthen, Tannery and Klein (to cite only a few), that Classical algebra, for instance, is the work of the Italian School perfected by Viete and Descartes.[3102] Did not Milhaud (1921) and Dieudonne (1974) trace the early history of Algebraic geometry back to Descartes? [3103] The modern mathematician's text is, in this respect, significant: between the Greek prehistory of algebraic

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[3101] John J O'Connor and Edmund F Robertson: *Arabic Mathematics*; op cit.
[3102] R. Rashed: *The Development of Arabic Mathematics: Between Arithmetic and Algebra;* Tr. A.F.W. Armstrong (Kluwer Academic Publishers; Dordrecht; 1994), p.339.
[3103] Ibid.

geometry and Descartes, Dieudonne finds only a void, which 'far from being frightening, is ideologically reassuring.'[3104]

These views are false on two essential grounds:

First, Muslim mathematics was superior in every possible respect to its Greek counterpart, Muslim mathematicians adding a vast new array of findings, and developments to the science.

Secondly, many mathematical accomplishments, thought to be of Western origin, are in fact, of Islamic origin.

On the first point, any comparative work between Greek and Muslim mathematics will prove the immense superiority of Islamic mathematics. Indeed, the medieval period, and the period between the mid 10th and mid 11th century, in particular, as noted by Berggren, was a highly creative period for many of the mathematical disciplines in Islam, that saw significant advances in arithmetic and algebra, the development of spherical trigonometry, and brilliant contributions to mechanics, optics, and cartography.[3105] This is highlighted by a few instances here. Suter, who studied Islamic mathematics in good detail, could write:

> 'In the application of arithmetic and algebra to geometry, and conversely in the solution of algebraic problems by geometrical means, the Arabs far surpassed the Greeks and the Hindus.'[3106]

The most famous contributions to this field were Ibrahim Ibn Sinan's (908-946) writings on the quadrature and the parabola, Abu Al-Wafa's (b.940-d. 997-8) writings on the construction of regular polygons involving cubic equations, and Abu Kamil's (850-930) writings on the pentagon and the decagon.[3107] Another example is of the depth of the mathematical tradition in mechanics as to be found in the correspondence between al-Kuhi (940-1000) and al-Sabi (fl. 10th century), part of which is summarised and studied by Sesiano.[3108] This correspondence is an example of serious work in Arabic on the determination of centres of gravity, which goes considerably beyond the work of Archimedes, and

[3104] Ibid.
[3105] J.L. Berggren: History of Mathematics in the Islamic World: The Present State of the Art. *Middle East Studies Association Bulletin* 19 (1985), pp. 9-33. pp. 27-8.
[3106] Quoted in R. Arnaldez-L.Massignon: Arabic Science; in *Ancient and Medieval Science*; ed by R. Taton (Thames and Hudson; London; English tr; 1963), pp. 385-421. at p. 408.
[3107] Ibid.
[3108] J. Sesiano: Note sur trois theorems de la mecanique d'Al Quhi et elur consequence; *Centaurus*; 22; (1979); pp. 281-97.

which contains discussions of interest for geometry and the philosophy of mathematics.[3109]

Rigour and ascertaining findings with precision was, as noted with previous sciences, a real demarcation line between Islamic and Greek science, and Berggren notes how in the 10th century there was a decided tightening of rigour in Islamic geometry, with the result that methods that had seemed perfectly acceptable to Archimedes were seen as needing further explanation.[3110]

Islamic mathematics, as will be amply discussed in the appropriate heading further on, above all, dwelt on practical problems in a way Greek mathematics never did.

In relation to the second point, as Islamic mathematics is examined more thoroughly, most particularly due to the works of scholars such as Djebbar, Rashed, Berggren, Saidan, etc, it comes to be realised that many former accomplishments thought to be Western, in fact, date from centuries earlier, back to the Islamic period. Recent research, as O'Connor and Robertson insist, is, indeed:

> 'Painting a very different picture of the debt owed to Islamic mathematics.. that modern mathematics is closer to Muslim mathematics than the Greek,... many of the ideas which were previously thought to have been brilliant new conceptions of European mathematicians of the sixteenth, seventeenth and eighteenth centuries are now known to have been developed by Islamic mathematicians centuries earlier.'[3111]

O'Connor and Robertson provide a good outline of the main Islamic mathematicians and their works to prove the point.[3112]

The same point was also made by Berggren, who insists on the mathematical autonomy and originality of Islamic civilisation, and how innovations in arithmetic and algebra that once seemed due to outside influence have emerged as integral parts of the corpus of Islamic mathematics.[3113]

Rashed, most particularly, gives instances, of how Muslim mathematicians of the 11th-12th centuries achieved results still incorrectly attributed to mathematicians of the 15th-16th centuries, for, instance, the

[3109] J.L. Berggren: The Correspondence of Abu Sahl al-Kuhi and Abu ishaq al-Sabi; said to appear in *Journal for the History of Arabic Science*; see J.L. Berggren: History of Mathematics; op cit; p. 27; note 16.
[3110] J.L. Berggren: History of Mathematics in the Islamic World; op cit; p. 23.
[3111] John J O'Connor and Edmund F Robertson: *Arabic Mathematics*; op cit.
[3112] Ibid.
[3113] J.L. Berggren: History of Mathematics; op cit; p. 27.

method attributed to Viete for the resolution of numerical equations; the method ascribed to Ruffini-Horner; general method of approximation, in particular the one Whiteside designated as the Al-Kashi-Newton method, and lastly the theory of decimal fractions.[3114] In addition to methods which were to be reiterative and capable of leading to in a recursive way to approximation, 11th and 12th century Muslim mathematicians also formulated new procedures of demonstration such as mathematical induction still found in the 17th century.[3115] Similarly, they engaged in new logico-philosophical-debate: for example, the classification of algebraic propositions and the status of algebra in relation to geometry. It was their successors who were to tackle the problem of symbolism.[3116] All of this is to say, Rashed concludes, that certain concepts, methods and results attributed to Chuquet, Stifel, Faulhaber, Scheubel, Viete, Stevin, etc, were actually the work of this tradition of al-Karaji's (953-1029) school, known furthermore to the Latin and Hebrew mathematicians.[3117]

Recent research, such as by Rashed himself and Djebbar, Berggren dates,[3118] has also shown that the study of number theory formed a continuous tradition and led to the discovery of theorems or problems usually ascribed to Western mathematicians several centuries later, such as the appearance of 'Wilson's' theorem in the work of Ibn al-Haytham, 'Bachet's problem of the weights in al-Khazini (fl.1115-1130), or the summation of the fourth powers of the integrers 1,2…., *n* in the work of the 10th century mathematician al-Qabisi.[3119]

In geometry, the Muslim pioneering role is noted by Yushkevitch, who observes how the birth of the theory of construction using a compass with only one opening was due to Abu Al-Wafa (940-998), a study of the problem only beginning in the time of the European 'Renaissance.'[3120] The theory of parallels was undertaken by al-Gauhari (ca 800-860), and followed up by Thabit Ibn Qurra (826-901), Ibn al-Haytham, Omar Khayyam (1048-1131), and others. The Muslims put forward ideas which were later developed by Saccheri and Lambert, and in fact the first propositions of non-Euclidian geometry dates from this time.[3121]

[3114] R. Rashed: *The Development of Arabic Mathematics*; op cit; p.341.
[3115] Ibid.
[3116] Ibid; pp.341-2.
[3117] Ibid; p.342.
[3118] J.L. Berggren: History of Mathematics in the Islamic World; op cit; p. 11.
[3119] See for this A. Anbouba: Un Memoire d'al-qabisi sur certaines summations numeriques. *Journal for the History of Arabic Science*; 6; pp. 208-81.
[3120] A.P. Yushkevitch: Commentary; in *Scientific Change;* edited by A.C. Crombie (Heinemann; London; 1963), p. 299.
[3121] Ibid.

This previous misattribution of modern mathematics to the Greeks, and to post 'Renaissance', modern Western scholars, just as other accomplishments are also wrongly attributed to them, had a particular colonial purpose. Joseph makes excellent comments on this, how such Eurocentric scholarship aimed at devaluing the contribution of the people under Western colonial rule so as to ease their subjugation and domination.[3122] The classical Eurocentric trajectory, as he calls it, deliberately passes scientific knowledge from the Greeks into a period of Dark ages, then a re-discovery of Greek learning leading to the Renaissance, itself leading to European hegemony over cultural dependencies.[3123] One such Eurocentric 'scholar', highly in vogue in Western history of science, Tannery, recalls that:

> 'The more one examines the Hindu and Arabic scholars, the more they appear dependent upon the Greeks….. (and) quite inferior to their predecessors in all respects.'[3124]

The same 'historian' also notes how Muslim algebra, for instance, 'in no way superseded the level attained by Diophantus.'[3125]

Demeaning the contribution of colonised people, generally the Muslims, was used to justify the colonial argument that the Westerner had taken over their country so as to civilise them, because, they (the Muslims) have an inferior civilisation.[3126]

The colonial argument was not alone in demeaning the Islamic role, though. As will be amply expanded in the final part of this work, hostility to Islam and thence to its civilisation date from the medieval period, and went on throughout the centuries, the argument remaining the same, only the form altering with time. The Muslim achievements such as in mathematics during the medieval period were, thus, deemed the work of the devil, and Muslim mathematics taken north of the Pyrenees by the future pope Sylvester II (pope 999-1003) was deemed 'Saracen magic.' It was said that he had bartered his soul with Satan whilst in Muslim Spain.[3127] This hostility took a turn for the worse in the later medieval and

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[3122] G.G. Joseph: *The Crest of the Peacock* (Penguin Books; 1991), at p 4.
[3123] Ibid.
[3124] Tannery ; 1887; p. 6: in. R. Rashed: *The Development of Arabic Mathematics: Between Arithmetic and Algebra;* Tr. A.F.W. Armstrong (Kluwer Academic Publishers; Dordrecht; 1994), p.338.
[3125] Tannery ; 1887; p. 5: in. R. Rashed: p.339.
[3126] On the Western argument for colonization in the name of the Civilising Mission, see, for instance, N. Daniel: *Islam, Europe and Empire* (University Press, Edinburgh, 1966). R. Kabbani: *Europe's Myths of Orient* (Mc Millan; 1986).
[3127] In William of Malmesbury, History of the kings of England, tr. Revd John Sharpe (London, 1815), P. 199, in L. Cochrane: *Adelard of Bath* (British Museum Press, 1994), p. 43; J.W Draper: *A History of the Intellectual Development of Europe*, op cit, Vol 2. p. 7.

Renaissance period,[3128] This hostility, as noted by Joseph, was stirred by colonial scholarship of the late 18th-19th century, and still prevails today amongst a scholarship that generally fails to dissociate itself from past antecedents.

It is certain that the Muslims, in mathematics, as in other sciences, relied on other traditions, the Chinese, above all, and also the Hindu and pre-Islamic cultures of the region. Hill, however, notes that Muslim mathematicians, in general, felt free to investigate aspects of the subject that appealed to their tastes and met their requirements and to pursue their investigations in any way they chose.[3129] They did not feel constrained to use any particular method of approach; no method was considered so superior to all others that it became dominant. Hill pointed to al-Karaji (fl 11th century), for instance, who totally neglected Indian mathematics.[3130] Yushkevitch maintains that in the case where Chinese and Indian scientists gave only a few rules for calculation, the Islamic mathematicians completed scientific theories.[3131] Compared with the works of Indian and Chinese scientists, Muslim mathematical works were more systematic, more complete, and distinguished by the greater use of proofs, even in books of a purely practical character.[3132]

Other civilisations provided the means, but the real force behind Muslim mathematics, as with the rest of the sciences and accomplishments in civilisation, remains the faith itself.[3133] Islamic practice demanded precise calculations in inheritance matters, commercial transactions etc.[3134] Arithmetic (*al-hisab)* was, as Ibn Khaldun observes in his Prolegomena, the first of the mathematical sciences to be used by the Muslims, being a means of solving such material problems that present themselves in daily life as assessment of taxes, reckoning of legal compensation, and division

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And whilst they were translating Muslim sciences, not a single translator of the 12th –13th century had a kindly or tolerant word for Islam; in N. Daniel: *The Cultural Barrier* (Edinburgh University Press, 1975), p. 171.

[3128] Petrarcha's hostility to both science and Arabism was 'comparable to the form of modern anti Semitism associating Jewishness with radicalism,' according to Sarton. G. Sarton: *Introduction;* vol III; op cit; p. 178.

[3129] D.R. Hill: Mathematics and applied science: in M.J. L. Young et al: *Religion, Learning;* op cit; pp 248-73; p. 251-2.

[3130] Ibid.

[3131] A.P. Yushkevitch: *Commentary*; op cit; p. 297.

[3132] Ibid.

[3133] See, for instance, King, D: *Science in the Service of Religion: the Case of Islam*, Impact of Science on Society 159 (Paris: Unesco, 1990).

[3134] See A. Djebbar: *Une Histoire*, op cit; p.206.

of inheritances according to Qur'anic law.[3135] Al-Baghdadi's *Takmila*, for instance, contains an example of arithmetical problems arising from Muslim religious requirements, namely the calculation of the community's share of personal wealth: the zakat.[3136] The surveys in the *Encyclopaedia of Islam* under the headings *'Mirat'* (Inheritance) and *'Faraid'* (Obligations) contain the basic stipulations of Islamic law on the topic.[3137] Al-Khwarizmi also says in the opening flourish of his book on equations:

> 'Numbers and shapes which man must understand thanks to the beneficence of God the creator who has bestowed upon man the power to discover the significance of numbers.'[3138]

The Islamic impact is also seized on by Wickens, who observes that:

> 'Mathematics is par excellence the great field of pure theory, of elegant and economical demonstration in the abstract,' all so close to Islam's view 'of the rational recognition of beauty in the ordering of things.'[3139]

Arabic, equally, played its part. Arabic, Arnaldez and Massignon observe, by facilitating 'the interiorisation of thought, is particularly suited to expressing exact scientific concepts and to developing them, in much the same way as mathematical concepts have evolved historically.'[3140] Stock, too, notes that Arabic is 'inherently a good language for expressing scientific constructions-a fact of considerable importance for mathematisation.'[3141]

The following outline serves to reinforce most of the points just made, especially with regard to the originality of Islamic mathematics, its pioneering aspects, and how it impacted on the Christian West and modern mathematics.

[3135] G. Anawati: Science; in *The Cambridge History of Islam;* in two vols; edited by P.M. Holt; A.K.S. Lambton; B. Lewis; vol 2 (Cambridge University Press; 1970), pp. 741-79; at p.750-1.

[3136] A.S. Saidan: *The Takmila fi al-Hisab by al-Baghdadi* (1985), was to appear in D. King and G. Saliba; 1985.

[3137] J.L. Berggren: History of Mathematics in the Islamic World; op cit; p. 13.

[3138] E. Grant, 1974, p. 107. In I. Grattan-Guiness: *The Fontana History of the Mathematical Sciences (*Fontana Press, 1997), p. 172-3.

[3139] G.M. Wickens: The Middle East; op cit; at p. 114.

[3140] R. Arnaldez-L.Massignon: Arabic Science; op cit; p. 403.

[3141] B. Stock: Science, technology and economic progress in the early Middle Ages, in *Science in the Middle Ages,* ed D.C. Lindberg (The University of Chicago Press, Chicago; 1978), pp. 1-51, at p. 13.

2. Algebra:

Writing on Algebra, O'Connor and Robertson explain that it:

> 'Was a unifying theory which allowed rational numbers, irrational numbers, geometrical magnitudes, etc., to all be treated as "algebraic objects". It gave mathematics a whole new development path so much broader in concept to that which had existed before, and provided a vehicle for future development of the subject. Another important aspect of the introduction of algebraic ideas was that it allowed mathematics to be applied to itself in a way which had not happened before.'[3142]

The word algebra was used for the first time by al-Khwarizmi, and the science named after the title of his *Kitab al Mukhtassar fi'l hisab al jabr wa'l muqabalah* (Compendious Book of Calculation by Completion and Balancing). The work of al-Khwarizmi is the first in which that word appears in the mathematical sense.[3143] 'Algebra means in Arabic 'restoration,' that is the transposing of negative terms of an equation to the opposite side.[3144] Algebra, as the form of the name indicates, is an Arabic word: *al-jabr*, which means the restoration of something broken, the amplifying of something incomplete.[3145] More often *jabr* is associated with *muqabala*, the balancing of the two sides of an equation.[3146] Sabra explains that the title of the treatise, '*al jabr wal muqabala*,' referred to the two operations used by al-Khwarizmi in the process of solving linear and quadratic equations, namely those of eliminating negative quantities and reducing positive quantities of the same power on both sides of the equation.[3147] Al-Khwarizmi's treatise thus started something new, its systematic approach represented by its reduction of the treated problems to canonical forms provided with proofs, and 'can be said to have impressed its character on subsequent algebraic works, even when these (like the treatises of al Karaji and Omar Khayyam) went far beyond it.'[3148]

[3142] John J O'Connor and Edmund F Robertson: *Arabic Mathematics*; op cit.
[3143] C. Singer: *A Short History of Scientific Ideas to 1900* (Oxford University Press; 1959), pp. 148-9.
[3144] Ibid.
[3145] G. Anawati: Science; op cit; p.753.
[3146] Ibid.
[3147] A.I. Sabra: The Scientific; op cit; P. 185.
[3148] Ibid.

Al-Khwarizmi's Algebra, including its pious introduction was rendered into modern English in 1831 by Frederick Rosen,[3149] who says:

> 'When I looked at *Kitab al-Jabr*... a textbook written over eleven hundred years ago, it was among the most lucid and useful I'd ever seen. It is straight forward and practical, full of examples, and al-Khwarizmi himself stated, deals with 'what is easiest and most useful in mathematics.'[3150]

Rosen observes that Al-Khwarizmi intended to teach:

> 'What is easiest and most useful in arithmetic, such as men constantly require in cases of inheritance, legacies, partition, lawsuits, and trade, and in all their dealings with one another, or where the measuring of lands, the digging of canals, geometrical computations, and other objects of various sorts and kinds are concerned.'[3151]

This does not sound like the contents of an algebra text, O'Connor and Robertson point out, however it is important to realise that the book was intended to be highly practical and that algebra was introduced to solve real life problems that were part of everyday life in the Islamic world at that time.[3152] Which leads to those fundamental sources of Islamic science: faith and practicality frequently encountered.

A number of Muslim scholars followed in the wake of al-Khwarizmi in dealing with the subject. Al-Mahani (born 820) conceived the idea of reducing geometrical problems such as duplicating the cube to problems in algebra.[3153] Abu Kamil (b. 850) solved complicated quadratic equations with irrational coefficients.[3154] Despite not using symbols, but writing powers of x in words, he had begun to understand what we would write in symbols as $xn+xm = x\ (m+n)$.[3155] He forms an important link in the development of algebra between al-Khwarizmi and al-Karaji. Al-Karaji (b. 953) is seen by many as the first person to completely free algebra from geometrical operations and to replace them with the arithmetical

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[3149] F. Rosen, ed: *The Algebra of Mohammed ben Musa (al-Khwarizmi)* (London: Oriental Translation Fund, 1831, Reprint: Hildesheim, Olms, 1986).
[3150] In A. Arndt: *Al-Khwarizmi: in From Five Fingers to Infinity*; Edited by F.J. Swetz (Open Court; Chicago; 1994); pp. 289-92; p. 290.
[3151] F. Rosen (ed. and trans.), The Algebra of Mohammed ben Musa (1831, reprinted 1986) in entry on al-Khwarizmi by John J O'Connor and Edmund F Robertson: *Arabic Mathematics*, op cit.
[3152] Ibid.
[3153] John J O'Connor and Edmund F Robertson: *Arabic Mathematics;* op cit.
[3154] J.P. Hogendijk: Algebra under Islam; in *Encyclopaedia*, (H. Selin edition), op cit; p. 638.
[3155] John J O'Connor and Edmund F Robertson: *Arabic Mathematics*; op cit.

type of operations which are at the core of algebra today.[3156] He treated various properties of quadratic irrationals, which Euclid had proved geometrically, and he also discussed cubic irrationalities, and explained the extraction of roots of a polynomial (which is assumed to be a perfect square).[3157] He was first to define the monomials, ... and to give rules for products of any two of these.[3158] He started a school of algebra which flourished for several hundreds of years, of which Al-Samawal, nearly 200 years later, was an important member. Al-Samawal (b. 1130) was the first to give the new topic of algebra a precise description when he wrote that it was concerned:

> ' ... with operating on unknowns using all the arithmetical tools, in the same way as the arithmetician operates on the known.'[3159]

Under the Muslims algebra became an independent science having its own fields of study and methods of research, which is obvious in the algebraic treatise of Omar Khayyam.[3160] Knowing the importance of cubic equations for the construction of trigonometrical tables and for the solution of geometrical problems, the detailed geometrical theory of cubic equations was constructed and used to determine upper and lower limits for their roots.[3161] Later an analogous study was made of quadratic equations by al-Kashi (1380-1429), and together with the geometrical theory number of approximate methods were invented (by al-Biruni), al-Kashi and others.[3162]

Islamic algebra, like other sciences, was transferred to Europe primarily in the 12th and 13th centuries. Sarton offers chronological and geographical pointers to follow its passage.[3163] He also provides a rich bibliography that can give answers to the inquisitive mind.[3164] There is also good

[3156] Ibid.
[3157] J.P. Hogendijk: Algebra; op cit; p. 638.
[3158] John J O'Connor and Edmund F Robertson: *Arabic Mathematics;* op cit.
[3159] Ibid.
[3160] A.P. Yushkevitch: Commentary; op cit; p. 298.
[3161] Ibid.
[3162] Ibid.
[3163] G.Sarton: Introduction, op cit; all three volumes need to be consulted.
[3164] Too many to list here, but well documented in G.Sarton: *Introduction*, op cit.

information provided by Van Der Waerden,[3165] Sesiano,[3166] and Kaunzner.[3167]

The particular transfer al-Khwarizmi's algebra to Europe is well outlined by Mahoney. He explains that Al-Khwarizmi's *Kitab al-mukhtasar...* (Compendious..) became in Latin simply *Liber algebre,* but only two of its three parts were transmitted to Europe, and they were separately.[3168] It was translated into Latin twice during the 12th century, by Gerard of Cremona who retained the Arabic title: *De jebra et almucabala*, and by Robert of Chester, who gave an exact Latin rendering of it *Liber restaurationis et oppositionis numeris*.[3169] The term "algebra" itself was first applied only to the first part translated by Robert of Chester in 1145, and by Gerard of Cremona several decades later. It set forth solution paradigms for six types of problems expressed in modern symbolism by the equations (1) $ax^2 = bx$, (2) $ax^2 = b$, (3) $ax = b$, (4) $ax^2 + bx = c$ (5) $ax^2 + c = bx$, and (6) $bx + c = ax^2$, where a, b, and c are all positive rational numbers.[3170]

The second part of al-Khwarizmi's treatise was transmitted through an expanded version of it by Abraham bar Hiyya (Savasorda in Latin), translated by Plato of Tivoli in 1145 as the *Liber embadorum* (Book of Areas). It adds algebra to the techniques of the mensurator by using it to solve problems of dividing areas and volumes into parts having a given relation, and of determining lengths from various combinations of dimensions.[3171] The third part of al-Khwarizmi's algebra deals with the division of inheritances and is partly found in the writings of Leonardo Fibonacci, the section as a whole remaining un-translated.[3172]

The place of Islamic algebra in modern mathematics has been studied by modern sources. There is a good summary by O'Connor and Robertson already referred to. Rashed is possibly the best source of information for either French or English readership.[3173] Particular Islamic algebraists such

[3165] B.L. Van Der waerden: *A History of Algebra, from al-Khwarizmi to Emmy Noether* (Springer, 1985).
[3166] J.Sesiano: *la Transmission des connaissances mathematiques* (Geneva, 1982).
[3167] W. Kaunzner: On the transmission of mathematical knowledge to Europe, *Sudhoffs Archiv*, 71, 129-40.
[3168] M. Mahoney: Mathematics; in *Dictionary of the Middle Ages*; Vol 8; pp 212-3.
[3169] F. Gabrieli: The Transmission of learning; and Literary influences in Western Europe; in *The Cambridge History of Islam;* P.M. Holt et all ed; op cit; pp. 851-89; at p.863.
[3170] M. Mahoney: Mathematics; op cit; pp 212-3.
[3171] Ibid.
[3172] Ibid.
[3173] R. Rashed: *The Development of Arabic Mathematics: Between Arithmetic and Algebra* (Dordrecht: Kluwer. 1994).

as Abu Kamil have been studied by many, including Weinberg[3174] and Levey.[3175] Al-Uqlidisi's algebra is accessible via an excellent translation by Saidan.[3176] The algebra of al-Khayyam is explored conjointly by Rashed and Djebbar.[3177] Rashed also sheds light on Sharaf Eddin al-Tusi's algebra,[3178] whilst Suter[3179] and Sezgin[3180] offer an overall, but thorough, picture of the science and its leading figures. King on the other hand shows the connection of algebra with other sciences.[3181]

3. Arithmetic and the Problem of Arabic Numerals:

Julian A. Smith notes how until recently, the Islamic contribution to arithmetic has been generally little known, though Muslim mathematicians pioneered a number of new techniques.[3182] Smith sums up some such accomplishments, including how Muslim mathematicians pioneered decimal arithmetic, and how they made considerable contributions to the ancient sexagesimal (base 60) system of arithmetic, which had been developed by the Babylonians around 2000 BC.[3183] This system was widely used for astronomical calculation throughout the ancient world. Sexagesimal addition, subtraction, multiplication, and division became so commonplace among Islamic astronomers, it was

[3174] J. Weinberg: *Die Algebra des Abu Kamil*. München: Druck des Salesianischen Offizin (1935).
[3175] M. Levey: *The Algebra of Abu Kamil*. Hebrew Text, Translation and Commentary with Special Reference to the Arabic Text, (Madison-Milwaukee, and London, 1966).
[3176] Al-Uqlidisi: *The Arithmetic of al-Uqlidisi*. Translated and annotated by A.S. Saidan (Dordrecht and Boston: Reidel, 1978).
[3177] R. Rashed and A. Djebbar, eds.*L'oeuvre algèbrique d'al-Khayyam* (Aleppo: IHAS, 1981).
[3178] R. Rashed: Résolution des equations numériques et algèbre Sharaf al-Din al-Tusi, Viète. *Archive for History of Exact Sciences* 12 (1974), pp.244-90.
[3179] H. Suter: Die Mathematiker und Astronomen der Araber und ihre Werke. *Abhandlungen zur Geschichte der mathematischen Wissenschaften* 10 (1900), ix+278 pp.
[3180] F. Sezgin: *Geschichte; op cit*.
[3181] Such as: D. A. King: *Al-Khwarizmi and New Trends in Mathematical Astronomy in the Ninth Century*. New York University: Hagop Kevorkian Center for Near Eastern Studies: Occasional Papers on the Near East 2 (1983).
[3182] J.A. Smith: Arithmetic in Islamic Mathematics; in *Encyclopaedia* (H. Selin ed); op cit; pp. 68-70; at p. 68.
[3183] Ibid; p. 70.

renamed 'the astronomer's arithmetic.'[3184] Muslim astronomers such as al-Kashi (1380-1429) used sexagesimal numbers to determine approximate roots, extract roots, and even find the fifth root of certain numbers.[3185] Yushkevitch, who did some pioneering works on Muslim mathematics and wrote on the particular contribution of Al-Kashi,[3186] stresses the importance of Muslim accomplishments in arithmetic.[3187] He too notes how in the realm of computing arithmetic, Muslims completed and perfected approximate methods for the extraction of roots, the procedures for the verification of calculations, their most favourable arrangements, and so on.[3188] Al-Kashi's calculation of [pi] to seventeen decimal places was a brilliant example of this, and in connection with the extraction of roots, we meet for the first time in al-Kashi the binominal theorem for any positive integrer exponent.[3189] The time and place of origin of this rule are unknown, but it was probably proposed by Omar Khayyam (1048-1131).[3190] The technique of operations on whole numbers and sexagesimal fractions had been perfected. Al-Kashi also introduced decimal fractions and stressed their advantages.[3191]

Centuries before him, al-Karaji's (fl. 1020) works included a manuscript on the rule of computation entitled *Al-Kafi fi al-Hisab* (Essential of Arithmetic). One of the major contributions of al-Karaji, noted by Rashed, was to conceive a new mathematical project: the arithmetisation of algebra. In the words of one commentator, he enabled the algebraist "to work with unknowns with all the arithmetic instruments, just as the arithmetician works with the knowns."[3192] This involves a transposition and extension of elementary arithmetic operations—the algorithms as well as Euclidean division or the extraction of roots—to algebraic terms and expressions, and particularly to polynomials.[3193] Thanks to the arithmetisation of algebra, al-Karaji arrived at the construction of the algebra of polynomials and also gained a better understanding of the algebraic structure of real numbers.[3194]

[3184] Ibid.
[3185] Ibid.
[3186] Such as A.P. Yuschkevitch; B.A. Rosenfeld: Al-Kashi; *Dictionary of Scientific Biography*; Edited by C.C. Gillispie; Charles Scribner's Sons; New York; 1974 fwd; vol; 7; pp. 255-62.
[3187] A.P. Yushkevitch: Commentary; op cit; p. 298.
[3188] Ibid.
[3189] Ibid.
[3190] Ibid.
[3191] Ibid.
[3192] In R. Rashed: Al-Karaji; in *Dictionary of the Middle Ages*; op cit; vol 7; p. 212.
[3193] Ibid.
[3194] Ibid.

Like other branches of Islamic mathematics, Muslim arithmetic was affected by practical considerations posed by the faith such as problems of inheritance and finance, and the need to calculate events in the lunar based Islamic calendar.[3195] The Islamic laws of inheritance, as found in the Qur'an, King points out, are complicated, and their application involves skills in arithmetic, and both legal scholars and certain mathematicians wrote on this subject.[3196] Al-Khwarizmi, for instance, devoted the second half of his treatise on algebra to the calculation of shares of an estate given to various heirs.[3197] These problems employed the arithmetic of fractions, and were heavily influenced by religious law and customs. A typical problem treated by al-Khwarizmi involves the calculation of the shares of a dead woman's estate that would accrue to her husband, her son, and her three daughters.[3198]

The numeral system (1, 2, 3, …) now taken for granted, remains by far one of the greatest scientific legacies to humanity. Centuries ago Arabic numerals were shunned in Western Christendom as symbols of the Muslim foe: money changers, for instance, were summoned to stick to the ancient method of 'the fathers' instead of making use of the Arabic numerals in their transactions.[3199] Until five to six centuries ago, demand by society and science hardly required the Arabic numerals (except by traders who used them more widely), and reliance on the Roman numerals was adequate.[3200] However, once we stepped into our modern times, and the decisive role of such numbers became fundamental for every calculation or operation, and they increasingly became the foundation of modern science, the Arabic/Islamic association with such numbers became less accepted. And so they began to be gradually taken away from the Muslims. These numbers, once rehabilitated, and having become the foundation of modern science, are now called Hindu Numerals, or

[3195] J.A. Smith: Arithmetic in Islamic Mathematics; op cit; p. 70.
[3196] D.A. King: Religion and Science in Islam; in *Encyclopaedia* (Selin edition); op cit; p. 861.
[3197] J.A. Smith: Arithmetic in Islamic Mathematics; p. 70.
[3198] Ibid.
[3199] D.J. Struik: The prohibition of the use of Arabic numerals in Florence: *Archives Internationales d'Histoire des Sciences* Vol 21 pp 291-4; p. 294:
[3200] The greater convenience of the Arabic numerals, Neill Wright, notes was only slowly realized, obvious as it seems to us. G.G. Neill Wright: *The Writing of Arabic Numerals* (University of London Press; London; 1952), p. 125.

according to a large number of Western historians, they are Greek.[3201] In respect to the latter, the numerals belong to this endless list of Greek scientific achievements lost for over ten centuries until they were recovered in the 12th-13th century in the West. This latter Greek origin of the numbers is defended by the likes of Bubnov, who late in the nineteenth century fought against the Hindu origin of such numerals, asserting that the fundamental elements of our present system were known in classical antiquity, and that the debt is to the Greeks not to the Hindus.[3202] Woepcke also argued the same origins, saying that these numerals had reached Spain through the neo Pythagoreans by c. 450 CE.[3203] These once shunned numbers in Western Christendom have become, thus, products of Western culture.[3204]
The situation we have today is that, these numerals, hated, despised, and rejected for centuries as a symbol of the hated Muslim foe, today are either Greek or Hindu, but definitely not 'Arab.' How such extremely opposed views can be reconciled is difficult to comprehend. How can the easy, obvious and simple facts that these numbers were acquired from the Muslims, that the Muslims have been using them for centuries in the western realm of Islam, and that it was the Muslims who wrote and explained their use, be rejected as weak evidence in favour of a Muslim source is equally hard to comprehend.

There is no need here to get bogged down in the argument of who invented these numerals, but for those eager to follow it, there are a number of good sources.[3205] All that needs to be said here is that the numerals are not of Roman or Greek, or of European origin at all. Such evidence relies on exuberant writings. Had they been European in origin, they would have been obviously present in lands where the Romans went,

[3201] See H.P. Lattin: The Origin of our present system of notation according to the theories of Nicholas Bubnov. In *ISIS*; XIX; pp. 181-94.
[3202] Ibid; p. 182.
[3203] See the brief discussion of the issue by M.C. Welborn: Ghubar numerals; in Notes and Correspondence; *ISIS*, Vol XVII; pp. 260-3.
[3204] at http://www.nlm.nih.gov/hmd/arabic/glossary.html, for instance.
[3205] For anyone interested in the debate of the issue, see:
-G.R. Kaye: l' Origine de notre notation numerique: *Scientia* XXIV, pp 53-55 (Bologna).
-I. Mouelhy: l'Origine Arabe des Chiffres et du zero, *Bulletin de l'Institut d'Egypte* (1993), pp. 43-69.
-G.G. Neill Wright: *The Writing of Arabic Numerals*; op cit.
-G.F. Hill: *The Development of Arabic Numerals in Europe* (Oxford, Clarendon, 1915).
-G.G.Joseph: *The Crest of the Peacock*; op cit.
-Arabia And The Middle East; Islam and Islamic History Section; *ARAMCO and Its World:* Ed by I.I. Nawwab, Peter C. Speers & Paul F. Hoye, 1980.

or where there was Greek impact before the Muslims. Not a single piece of writing, or archaeological finding, or anything whatsoever bears any evidence of their existence in Europe before the Muslims. The numerals are not wholly Arabic either, nor are they Hindu. There is surely something Hindu (not in the form but in certain functions) and something from the Western side of the Islamic world (as these numbers were predominantly used in North Africa and Spain). Thus, they are the outcome of a combinatory exercise of techniques and methods, which the Muslims amalgamated, developed, and adapted to their use and practical needs. They are, thus, a concoction from the Hindu and from the Muslim mathematicians themselves. As for the word Hindi related to such numerals, which has been used by some to justify the attribution to the Hindu, this has been explained by Kaye and Carra de Vaux, most particularly. For Carra de Vaux, for instance, the word *Hindi* is easily confused in the Arabic script with *hindasi* which means what relates to geometry or the art of the engineer.[3206]

The most important remark to make in relation to these decimals, and here was where Islamic genius lay, is the manner by which Muslims recognised their importance earlier than anyone else. The greater Muslim contribution was in developing and shaping the use of such numerals according to uses that are not just valid in our modern world, but are its very foundations. These numerals, furthermore, contributed decisively to the advance of mathematics and, as put by Wickens, opened a door to progress that it is difficult to imagine without them.[3207] It is very difficult to see what could have been done with Roman numerals; eight (8), for example, in Roman is VIII; Forty-seven (47) is XXXXVII. One can imagine the struggle in making the simplest of calculations with such Roman numerals; complex calculations are impossible with them. In fact, the use of Roman numerals in the West, according to Watt, retarded the advance of mathematical theory.[3208] The nine decimals, in addition to the Zero, in the end, in agreement with Wickens could be said to be 'nearly as great a revolution as the art of writing.'[3209]

The manner the knowledge of such decimals was transferred to us is crucial. Al-Khwarizmi's main work other than his algebra was a treatise on arithmetic, in which the numerals were presented and the place value

[3206] Carra de Vaux: Astronomy and Mathematics, op cit, p. 384.
[3207] G.M Wickens: What the West borrowed, op cit, p. 122.
[3208] W.M. Watt: *The Influence,* op cit, p. 63.
[3209] G.M. Wickens: What the West, op cit, p. 122.

system was explained. This textbook was the earliest written on the decimal system, representing a milestone in the development of mathematics and science.[3210] In it, Al-Khwarizmi demonstrates the basic operations of addition, subtraction, division and multiplication, and shows how to work with fractions and how to extract square roots, all operations greatly simplified by the new system.[3211] The Latin translation of this work begins with the words *Dixit algorismi*, or 'Algorithm (Al-Khwarizmi) says, and follows with instructions for making various computations, thus Algorithm, a Latinised version of Al-Khwarizmi's name, has come to its present meaning of a general computational procedure.[3212]

With regard to the transmission of the numerals to the Christian West, Sarton explains that the writings of al-Kindi and al-Khwarizmi were in all probability the main channels through which they became known in Islam and later in the West.[3213] The earliest Muslim documents bearing such numerals date from 874 and 888; and their propagation must have been speeded by an exceedingly active trade, that reached every part of the world.[3214] Al-Khwarizmi, according to Arndt, was enormously popular and avidly studied in the West, and was instrumental in effecting Europe's conversion from the cumbersome Roman numerals to the present day system.[3215] The first translation of Al-Khwarizmi into Latin was by Adelard of Bath in 1126.[3216] However, the earliest and best known practical attempt to introduce north of the Pyrenees Islamic mathematics, including the numeral system, was made by Gerbert of Aurillac (Pope Silvester 999-1003). This was met with great opposition, though; Gerbert's mathematics were called 'A Dangerous Saracen magic.'[3217] By the 13th century, things evolved, and a better appreciation of the Muslim system took place, witness one Fibonacci, who was part of the Pisan trading colony in the Algerian city of Bejaia, and who concluded the superiority of Arabic numerals and Muslim methods of calculations, and so sent his son Leonardo to learn mathematics there.[3218] The outcome of such studies was The *Liber Abacci* of Leonardo of Pisa, whose second

[3210] A. Arndt: Al-Khwarizmi; op cit; p. 291.
[3211] Ibid.
[3212] Ibid.
[3213] G. Sarton: *Introduction;* vol 1; op cit; p. 585.
[3214] Ibid.
[3215] A. Arndt: Al-Khwarizmi; op cit; p. 291.
[3216] Ibid.
[3217] William of Malmesbury: History of the kings of England, in L. Cochrane: *Adelard of Bath,* op cit, p. 43.
[3218] W. Montgomery Watt: *The Influence of Islam on Medieval Europe* (Edinburgh, 1972), pp. 63-4.

edition would establish the 'Andalusian number system as the basis of modern mathematics.'[3219] It seems, though, that a much more popular work than Leonardo's that employs the Arabic numerals was the *Algorismus* of John of Holywood, who was a teacher in Paris.[3220] John of Holywood's (d. 1250) book on arithmetic, or rather 'algorisms,' was extremely popular, and did more to introduce the Muslim notation than any other, and was frequently re-printed down to the 17th century.[3221] Wright, however, notes the slow progress of the use of the numerals,[3222] and Sir Hilary Jenkinson reminds us that until well into the 17th century the counting board and the old method of digital computation were in general use in England, and that until the very end of this century writing masters did not include copies of Arabic figures in their books.[3223] After that they increasingly became the foundation of all calculations, modern science and civilisation, and, of course, simultaneously, also began to lose their 'Arabic' parenthood.

4. Other Branches, and the Practical Nature of Islamic Mathematics:

When the traveller Leo the African came to Fes, he noted something remarkable there: a chemical society, and he wrote of them:

> 'A stupid set of men who contaminated themselves with sulphur and other horrible stinks.'[3224]

One of the greatest reproaches made to Muslim science and mathematics by Western historians of science, and mathematics, in particular, was their practical aspect. Whereas Western science, in its origins as well as in the era of classical modernity, paid particular attention to theoretical foundations, Oriental science is defined essentially by its practical

[3219] M.R. Menocal: *The Arabic Role;* op cit; p.62.
[3220] C. Singer: *A Short History of Scientific Ideas to 1900* (Oxford University Press; 1959), pp.174-5.
[3221] Ibid.
[3222] G.G. Neill Wright: *The Writing of Arabic Numerals*; op cit; p. 123 fwd.
[3223] H Jenkinson: The Later Court Hands in England; (1927); p. 95; in G.G. Neill Wright: The Writing; op cit; p. 129.
[3224] Quoted by R.H. Major: *A History of Medicine;* 2 Volumes (Blackwell; Oxford; 1954) vol 1; p. 259.

aims.[3225] Oriental science, and Muslim science in particular, is said to allow itself to be carried away by empirical rules and practical aims.[3226] Indeed, as the following will serve to highlight the principal point made in this work that by its very nature, Islamic science differs fundamentally from its Greek predecessor mainly due to its practical nature. This practical nature, thus, denotes that the real source of Islamic mathematics, just like all Islamic science, was fundamentally not Greek science. The foundation for it, once more, was the faith, which imposed upon Muslim scholars the need to research solutions for practical problems of the community. Sciences and learning in Islam, as I and L Al-Faruqi correctly point out, have to have a purpose, and it is the practical knowledge that produces results and leads to virtue, the object of the Muslim's prayer: 'O God grant us knowledge that is useful and beneficial.'[3227] This, as has been seen in the many preceding sciences, is also the case in mathematics in its diverse branches.

As Sabra puts it, 'no mystery' surrounds Islamic geometry; 'it was Greek in origin, methods and terminology.'[3228] But two major remarks can be added here: one on the additional findings and studies by Muslim mathematicians, and the other, of course, the practical end of their work.
On the first point, profiting by the researches of Ibn al-Haytham (965-1040) on a theorem not proved by Archimedes in his *On the Sphere and the Cylinder*, al-Kuhi (940-1000) constructed a segment of a sphere equal in volume to the segment of a given sphere and in its surface area to another segment of the same sphere.[3229] He resolved the problem very ingenuously with the help of two auxiliary cones and the intersection of two auxiliary conic sections-a hyperbola and a parabola.[3230] Ibn al-Haytham, himself elaborated upon Euclid's fifth postulate, using a triangular quadrilateral (called in the West, Lambert's Quadrangle.)[3231] Euclid also attracted the focus of Al-Hajaj ibn Yusuf who was the first translator of his elements into Arabic. Al-Abbas wrote commentaries upon them, and Abu Said al-Darir wrote a treatise on Euclidian geometrical problems.[3232] Regard for Euclid did not stop Islamic mathematicians from

[3225] In R. Rashed: *The Development of Arabic Mathematics*; op cit; p.338.
[3226] Ibid; p.338-9.
[3227] I.R. and L.L. Al-Faruqi: *The Cultural*; op cit; p.230.
[3228] A.I Sabra: The Scientific Enterprise; op cit; p. 185.
[3229] G. Anawati: Science; op cit; p.752.
[3230] Ibid.
[3231] M. A. Kettani: Science, op cit, p. 72.
[3232] G. Sarton: *Introduction*; Vol 1; op cit; p. 545.

questioning and refuting him when necessary, though.[3233] Muslim mathematicians also used Greek techniques to formulate and solve new problems, making rearrangements or extensions of Euclid's theorems. Attempts to prove Euclid's parallels postulate have been found in their writings dating from the 9th to the 13th century. Rather than acquiesce in a ready made solution, they pursued the search for ever better solutions, formulating and proving some non Euclidean theorems; one of their attempts to prove the postulate later became known to European mathematicians such as Wallis and Saccheri.[3234]

An aspect of geometry of special interest to Muslim authors was its use in making calculations.[3235] Amongst these are Ibrahim Ibn Sinan's treatise on the quadrature of the parabola, Abu'l Wafa on the construction of regular polygons, which led to the equations of third degree, and Abu Kamil on the construction of the pentagon and the decagon, also by means of equations.[3236]

With regard to the second development, i.e the practical nature of geometry in Muslim hands, this is where lies the fundamental Islamic contribution to the science. Geometry was applied to many practical problems such as surveying, studies in mechanical tools, the construction of improved mills, of norias (wheels with scoops for the continuous drawing of water,) mangonels, tractors etc.[3237] Ozdural notes how mathematicians, who taught practical geometry to artisans, played a decisive role in the creation of patterns in Islamic art, and also in designing buildings.[3238] Mathematicians gave instructions to artisans on certain principles and practices of geometry.[3239] They also worked on geometric constructions of two or three dimensional ornamental patterns or gave advice on the application of geometry to architectural construction.[3240] In his Book *On What is Necessary From Geometric Construction for the Artisan,* Abu'l Wafa (940-998) gave solutions of two and three dimensional problems 'A form of geometry that would have upset the Greeks, to whom geometry was solely theoretical art,' says Ronan.[3241] In this work, Abu'l Wafa displays knowledge of pure

[3233] A.I. Sabra: The Scientific; op cit; p 185.
[3234] Ibid.
[3235] G. Anawati: Science; op cit; p.752.
[3236] Ibid.
[3237] Ibid; p.753.
[3238] A. Ozdural: Mathematics and Arts: Connections between Theory and practice in the Medieval Islamic world; in *Historia Mathematica*; 27 (2000); pp. 171-201; at p. 171.
[3239] Ibid; p. 172.
[3240] Ibid.
[3241] C.A. Ronan: The Arabian Science, op cit, p. 225.

geometry, familiarity with practical applications, and skill in teaching theoretical subjects to practical minded people.[3242] Abu'l Wafa also provides us with insight into the collaboration of mathematicians and artisans in the Islamic world, telling how he attended meetings between mathematicians and artisans in Baghdad.[3243] Omar Khayyam (1048-1131), likewise, shows the same practical concern, solving a right triangle with the aid of cubic equations in one of his treatise following a question at a meeting attended by geometers and artisans.[3244] For his part, in referring to carpentry, Ibn Khaldun says that:

> 'It needs a good deal of geometry.... In order to bring the form (of things) from potentiality into actuality in the proper manner.[3245]

It is not just geometry, but all aspects of Islamic mathematics, which adopt and respond to practical problems. Al-Farabi's (d.950) words, in fact captures this concern with perfection. In his Classification of the Sciences, we find, it is 'to determine the means by which those things whose existence is demonstrated in the various mathematical sciences can be applied to physical bodies.'[3246] He explains that

> 'In order to produce the truths of mathematics artificially in material objects, the latter may have to be subtly altered and adapted. In this sense, the 'science of devices' is a general art which includes algebra (on this account a kind of applied arithmetic that seeks to determine unknown numerical quantities) as well as building, surveying, the manufacture of astronomical, musical and optical instruments, and the design of wondrous devices. All these and similar arts are principles of the practical crafts of civilisation.'[3247]

Al-Farabi offers us an exciting passage on the science of mechanics and other devices, and of which Saliba[3248] provides an excellent English

[3242] A. Ozdural: Mathematics; op cit; p. 174.
[3243] Abu'l Wafa al-Buzjani: *Kitab fima yahtaju al-sani min amal al-handasa (On the geometric construction necessary for the artisan)*; Istanbul; Sulaymania; p. 53 in A. Ozdural: Mathematics; op cit; p. 171.
[3244] A. Ozdural: Mathematics; op cit; p. 171.
[3245] Ibn Khaldun: *The Muqqadimah;* tr F. Rosenthal; Bollingen Series XLIII (Princeton University Press; 1958), vol 2; p. 365.
[3246] In A.I. Sabra: The Scientific; op cit; p. 186.
[3247] Ibid.
[3248] G. Saliba: The Function of Mechanical Devices in Medieval Islamic Society; in *Science and Technology in Medieval Society*; Edited by P.O. Long; The Annals of the New York Academy of Sciences (New York; 1985), pp. 141-51; at pp. 145-6.

translation unavailable anywhere else, and surely a translation that cannot be matched (due to Saliba's proficiency in both Arabic and English):

> 'The science of mechanics (Hiyal) is the knowledge of the procedure by which one applies all that was proven to exist in the mathematical sciences that were mentioned above in statements and proofs to the natural bodies, and the act of locating all that, and establishing it in actuality. The reason for that is that these mathematical sciences concern themselves with lines, surfaces, volumes, numbers, and bodies. When one wants to locate these ideas that form the subject matter of the mathematical sciences and wilfully exhibit them, by means of a craft, in the natural bodies that are perceptible to the senses, one needs a force through which he proceeds to establish them in these bodies and to apply these ideas to these bodies. For the material and perceptible bodies have special conditions that prohibit them from accepting the ideas that were demonstrated by proofs from being located in them as one pleases to do. On the contrary, these natural bodies have to be prepared to accept what one seeks to establish in them, and one has to contrive to remove the obstructions.
>
> The sciences of mechanics are therefore those that supply the knowledge of the methods and the procedures by which one can contrive to find this applicability and to demonstrate it in actuality in the natural bodies that are perceptible to the senses.
>
> Of these mechanical sciences are the many arithmetical ones including the science known to the people of our times as the science of algebra, for it partakes of arithmetic and geometry...
>
> Among them (i.e the mechanical sciences) also, are the many geometric (or engineering, handasiya) mechanical sciences, such as:
>
> -The art of overseeing construction.
>
> -The devices for determining the areas of bodies.
>
> -The devices used in the production of astronomical and musical instruments and in the preparation of instruments for many practical crafts such as bows and arrows and various weapons.
>
> -The optical devices used in the production of instruments that direct the sight in order to discern the reality of the distant objects, and in the production of mirrors upon which one determines the points that reverse the rays by deflecting them or by reflection or refraction. With this, one can also determine the points that reverse the sun's rays into other bodies, thus producing the burning mirrors and the devices connected with them.

> -The devices used in the production or marvellous objects, and the instruments for the several crafts.
>
> These and their likes are the mechanical sciences which in turn are the principles of the civil and practical crafts that are applicable to bodies, shapes, positions, order, and assessments such as in the crafts of masonry, carpentry and others.
>
> These are the mathematical sciences and their divisions.'[3249]

The Muslim scientists involved in the design, construction and use of such devices: i.e the Banu Musa, al Biruni, al Karaji, Omar Khayyam, Ibn al Haytham etc, were not just distinguished mathematicians, but were also men of practical skills, their science aiming at meeting practical needs.[3250] And so did Al-Kindi, whose medical treatise established posology on a mathematical basis.[3251] A century later, Abu'l-Wafa, better known for his works on geometry, also wrote *A Book on What is Necessary From the Science of Arithmetic for Scribes and Businessmen,* And the *Arithmetic for Government Officials.*[3252] Ibn Al-Samh who lived at Granada (d.1035) wrote on mental calculus (*hisab al-hawai*) on the nature of numbers and geometry, but most of all treatises on commercial arithmetic (*Al-mu'amalat*).[3253] Abu Muslim Ibn Khaldun (d. 1057) wrote mathematical works dealing with business arithmetic for sale of merchandise, measurement of land, calculating charity taxes, and other business transactions.[3254] From North Africa, the author of *Kitab maqayis al-Juruh* [Book of the Measures of Wounds] describes the method for measuring all types of wounds and the way to calculate the legal indemnities demanded by victims.[3255] Ibn al-Banna (b. Marrakech 1256) wrote *Tanbih al-albab,* which gives precise mathematical answers to the composition of medicaments, the calculation of drop irrigation of canals, arithmetical explanations of Qura'nic law of inheritance, explanation of frauds related to instruments of measurement, the exact calculation of legal tax in the

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[3249] Al-Farabi: *Ihsa' al-Ulum*; edited by O. Amin; Al-Maktaaba al-Anglo-Misriya (Cairo; 1968), pp. 108-110.

[3250] A.I. Sabra: The Scientific; op cit; p. 186.

[3251] G. Sarton: *Introduction;* vol 1; op cit; p.547.

[3252] A.S. Saidan: *Ilm al-Hisab al-Arabi-Hisab al-Yad* (Arabic Arithmetic) The Arithmetic of Abu'l Wafa al-Buzjani; (Amman; Jamiat umml al-matabi' alta'anawiyat; 1971).

[3253] G. Sarton: *Introduction*; Vol 1; op cit; p. 715.

[3254] In Said Al-Andalusi: *Tabaqat al-Umum;* Cairo Nd edition; p. 95; in A. Chejne: *Muslim Spain;* op cit; p.349.

[3255] A. Djebbar: Mathematics in Medieval Maghreb; *AMUCHMA Newsletter* 15 (1995), pp. 3-42.

case of a delayed payment, etc.[3256] Furthermore, as Arnaldez and Massignon note, practical problems also brought the Muslims face to face with such progressions as the sum of even or odd numbers, though they failed to prove their generality.[3257] Muslim arithmetical texts also refer to weights and measures, to the purity of coins and to the methods of counting.[3258] In the 15th century, Al-Kashi wrote a treatise entitled *Miftah al-Hisab* (The Key to Arithmetic,) which was intended for the use of merchants, clerks and surveyors, as well as theoretical astronomers.[3259] Al-Kashi also solved a problem about a triangular levelling instrument at the construction site of the observatory of Samarkand during a meeting of artisans, mathematicians, and dignitaries.[3260]

Mathematical geography developed largely out of the need to find distances to, and directions of, Makkah. The fundamental Muslim source of determining latitudes and longitudes of cities, the distance between them, and the azimuth of one relative to another is al-Biruni's *Kitab Tahdid al-Amakin* (Book of Demarcation) which has been edited in Arabic by Bulgakov[3261] and translated into English by Ali.[3262] Al Biruni also wrote *Kitab Tastih al-Kuwar* which is devoted to map projections, has been edited into Arabic by Saidan,[3263] and translated into English by Berggren, in 1982.[3264] In this treatise, al-Biruni mentions al-Saghani's generalisation of the astrolabic projection (stereographic projection), which is studied by Lorch 1985.[3265] Map and astrolabe projection belonged in the Islamic classification of sciences to the science of

[3256] See
-A. Djebbar: Mathematics; op cit.
-A. Djebbar: Le Traitement des fractions dans la tradition mathématique arabe du Maghreb. in: P. Benoit, K Chemla, J. Ritter ed: *Histoire de fractions, fractions d'histoire* (Basel: Birkhäuser, 1992), pp. 223-45.
[3257] R. Arnaldez-L. Massignon: Arabic Science; op cit; p. 406.
[3258] Ibid.
[3259] A.I. Sabra: The Scientific; op cit; p. 184.
[3260] Ghiyath al-Din Jamshid al-Kashi, *Ghiyatth al-Din al-Kashi's letter on Uluh Beg and the scientific activity in Samarkand patronized by him*; trans, A. Sayili; Ankara; Turk Tarikh Kurumu Basmevi; (1960); P. 101.
[3261] P.G Bulgakov Ed: T*ahdid al-Amakin*; published in Ma'jalat ma'had al-Makhtutat al-Arabiya (Cairo; The Arab League; 1962).
[3262] J. Ali: Trans: *The Determination of the Coordinates of Cities* (Beirut; American University; Beirut Press; 1967).
[3263] A.S. Saidan: Computational techniques in a set of late medieval astronomical tables; *Journal of the History of Arabic Science*; vol 1 (1977); pp. 24-32.
[3264] J.L. Berggren: Al-Biruni on plane maps of the sphere; *Journal of the History of Arabic Science*; vol 6 (1982); pp. 47-112.
[3265] R. Lorch: Al-Saghani's treatise on projecting the sphere to appear in King and Saliba (1985).

instruments, and the publications by King[3266] and Lorch contain expositions of the theory and history of several instruments designed to produce solutions to a large number of problems arising in applications of mathematics.[3267]

Trigonometry has extensive links with astronomy; trigonometrical applications serving to solve astronomical problems, and also problems of a practical nature.[3268] Al-Battani (850-929) was the first to use the expressions "sine" and "cosine"; and was very much aware of the superiority of his 'sines' over the Greek chords.[3269] He computed to a very high degree of accuracy the first complete tables of sines, tangents and co-tangents, and established the fundamental trigonometrical relations by introducing the notion of trigonometrical ratios. Al-Battani also applied algebraic operations to trigonometric identities, and his methods were widely used by Regiomontanus.[3270] The Muslims innovated in the invention of plane and spherical trigonometry.[3271] Abu'l-Wafa, making a special study of the tangent, tabulated its values, and introduced the secant and the cosecant.[3272] He knew the simple relationships between these six basic trigonometric functions, which are often used even today to define them.[3273] Carra de Vaux has demonstrated, following Moritz Cantor, that it was Abu'l-Wafa and not Copernicus who invented the secant; he called it the 'diameter of the shadow' and set out explicitly the ratio in its modern form.[3274] Ibn Hamzah al-Maghribi (16th century) from Algeria, surpassed Ibn Yunus (950-1009) towards logarithmic operations in his work on geometric progression. He established the following theorem:

> 'The order of any given term of a geometric progression, starting with unity, equals the sum minus unity of the powers of the common ratio of the two terms whose product equals the given term.'[3275]

[3266] D. King: An analog computer for solving problems of spherical astronomy; *Archive Internationale d'Histoire des Sciences*; vol 24; pp. 219-42.
[3267] J.L. Berggren: History of Mathematics; op cit; pp. 26-7.
[3268] A. Von Braunmuhl: *Vorlesungen Uber Geschichte der trigonometrie*, 2 vols (Leipzig, Teubner; 1900-3).
[3269] A. Al-Dafaa: *The Muslim Contribution to Mathematics* (Croom Helm, London; 1977), p. 70.
[3270] C. A. Ronan: The Arabian Science, op cit, p. 224.
[3271] Carra de Vaux quoted in G. Anawati: Science; op cit; p. 754.
[3272] G. Anawati: Science; op cit; pp. 754-5.
[3273] Ibid.
[3274] Carra de Vaux quoted in G. Anawati: Science; op cit; p. 755.
[3275] M. A. Kettani: Science, op cit, p. 72.

In the Christian West, the subject only made its beginnings in the 14th century at Merton College, Oxford.[3276]

Again, trigonometry arose as means to respond to the requirements of the faith, and it progressed in order to resolve such practical problems. Abu'l Wafa, for instance, used trigonometry in order to calculate the distance between Baghdad and Makkah.[3277] A standard application of trigonometric methods was in calculating both the times of prayers and the direction of Makkah for the same purpose.[3278] Over the centuries, numerous Muslim scientists discussed the Qibla problem, presenting solutions by spherical trigonometry, or reducing the three dimensional situation to two dimensions, and solving it by geometry or plane trigonometry.[3279]

There are also methods, which, although non trigonometric, developed side by side with trigonometric methods and interacted with them in a way whose history is yet to be written.[3280] One such method, involving rotation and orthogonal projection of arcs on a sphere into one plane, is that of the anlemma, and aspects of its history as relating to the problem of finding the direction of prayer are discussed by Berggren.[3281]

All these mathematical subjects and their applications travelled to the Christian West. The ideas and methods elaborated or perfected in the Islamic countries took root and led to new results in the most advanced European countries.[3282] Yushkevitch notes how this is the case in the books of Leonardo of Pisa (Fibonacci) (fl 1202), who emphasises the significance of Islamic science for the Latin people, just as others before him did.[3283] The significance of Islamic mathematics (and astronomy) had been earliest understood in Lotharingia, modern day Lorraine in France, which pioneered in the transmission of Muslim mathematics (and early astronomy) to the Christian West. This followed the visit of John of Gorze (970-4) to Spain, and his taking back Muslim manuscripts north of the

[3276] G. Sarton: *Introduction,* op cit, vol 2, p. 12.
[3277] E.S. Kennedy: Applied Mathematics in the 10th century: Abu'l Wafa calculates the distance Baghdad-Mecca; *Historia Mathematica*; vol 11 (1984), pp. 193-206.
[3278] D.A. King: Kibla in *Encyclopaedia of Islam*; second ed; vol 5, pp. 83-8.
[3279] D.A. King: Religion and Science in Islam; in *Encyclopaedia* (Selin edition); op cit; p. 860.
[3280] J.L. Berggren: History of Mathematics; op cit; p. 25.
[3281] J.L. Berggren: A comparison of four analemmas for determining the azimuth of the Qibla; *Journal of the History of Arabic Science;* vol 4; pp. 69-80.
[3282] A.P. Yushkevitch: Commentary; op cit; p. 300.
[3283] Ibid.

Pyrenees.[3284] Following John's trip, mathematics thrived in the schools of Lorraine, and from that region scientific learning 'radiated' to other countries: Germany, France and England.[3285] Not long after John, came the famed trip to Spain by the future pope, Gerbert of Aurillac, who despite hostile reception of his 'Saracen' mathematics, still impacted greatly on the sciences of the Christian West.[3286] Toledo's 12th century role is famed, its school of translation playing a leading part in the introduction of Islamic learning into Europe. To Toledo went Gerard of Cremona, John of Seville, Robert of Chester and all the great translators of the age. Plato of Tivoli's translation of Al-Battani in 1145 as *Liber enbadorum,* for instance, introduced Muslim trigonometry and mensuration into the West, and had great impact on the geometry of Leonardo of Pisa.[3287] Gerard of Cremona translated mathematical treatises by the Banu Musa, al-Khwarizmi, al-Farghani, Thabit Ibn Qurra, Abu Kamil, al-Zarqali, and Jabir Ibn Aflah. The translations of Robert of Chester and Adelard of Bath of al-Khwarizmi were also decisive for the advance of European mathematics.[3288] Muslim works on geometry and trigonometry became known to the Latins through the translation of the *Liber trium fratrum* (On the Measurement of Plane and Spherical Surfaces) written by the three Banu Musa brothers.[3289] The early 13th century revolution in European arithmetic was due to Fibonacci, whose father (a Pisan merchant), whilst trading with the Muslims, discovered the superiority of Arabic numerals, and so sent his son to study in the city of Bejaia (Algeria) with a Muslim teacher.[3290] The resulting outcome in 1202 was Leonardo's treatise: *Liber abaci*, which according to Sarton, was 'the first monument of European mathematics.'[3291] Despite all such transfers, as Hogendijk points out, the transmission of Muslim mathematics to the Christian West was far from complete, and until 1450 the level of mathematics in Europe was below that in the Islamic world.[3292] A later transfer concerns Al-Kashi's treatise *'The Key to Arithmetic'*, whose use of decimal fractions was noted in a Byzantine document which made its way

[3284] M.C. Welborn: Lotharingia; op cit; J.W. Thompson: The Introduction of Arabic Science; op cit.
[3285] L. Cochrane: *Adelard of Bath,* op cit, p. 6.
[3286] R. Allen: Gerbert Pope Sylvester II; *The English Historical Review;* (1892): pp 625-68.
[3287] C.H. Haskins: *Studies in the History*; op cit; p. 11.
[3288] See: C.H. Haskins: *Studies;* op cit; L. Cochrane: *Adelard*; op cit; etc.
[3289] F. Gabrieli: The transmission of learning; and Literary influences in Western Europe; in *The Cambridge History of Islam;* P.M. Holt et all ed; op cit; pp. 851-89; at p.864.
[3290] W.M. Watt: *The Influence*, op cit, pp. 63-4.
[3291] G. Sarton: *Introduction,* op cit, p.7.
[3292] J.P. Hogendijk: Algebra; op cit; p. 640.

to Vienna in 1562.[3293] All the discoveries of Muslim mathematicians did not become known to Europeans, but those that did, Yushkevitch insists, considerably enriched mathematical knowledge,[3294] and it would be a mistake to underestimate the role of Muslim mathematics in the progress of sciences in Europe.[3295]

Concluding Words: The Need for Further Study of the Legacy of Islamic Mathematics:

In his conclusion on the state of the studies of Muslim mathematics, Berggren insists that

> 'Since past researches now allow us to identify with some certainty the major figures in the history of Islamic mathematics, it is important that scholars begin to publish series of works by these men or their students. Only on the basis of reliably edited texts can the history of Islamic mathematics move beyond what has often been a random development dependent on chance discoveries, and so explore the many inviting avenues that now appear to be open to further research.'[3296]

Focus might also be first placed on an early figure, Al-Kindi (801-873), who wrote on spherical geometry and its uses in astronomical works, and an introduction to arithmetic and the theory of numbers.[3297] As one of the earliest scholars/mathematicians of Islam, his work can unravel some fundamental issues on the innovative character of Islamic mathematics, and how it developed. The Banu Musa brothers (early 9th century), who among others wrote on the measurement of the sphere, and discovered kinematical methods of trisecting angles and of drawing ellipses,[3298] by being like al-Kindi some of the pioneering Islamic scientists, can also throw light on the early developments of Islamic mathematics. Al-Biruni's mathematical works also require sustained interest, for, as noted by

[3293] A.I. Sabra: The Scientific; op cit; p. 184.
[3294] A.P. Yushkevitch: Commentary; op cit; p. 300.
[3295] Ibid.
[3296] J.L. Berggren: A History of Mathematics; op cit; p. 28.
[3297] See J. Jolivet; R. Rashed: Al-Kindi; *Dictionary of Scientific Biography*; Vol 15; Supplement I; pp. 261-6.
[3298] G. Sarton: *Introduction;* vol 1; op cit; p. 545.

Meyerhof, they have hardly been touched;[3299] and knowing al-Biruni's contribution, his works must have many answers to unresolved issues. The mathematics of North Africa would have remained totally unknown has not it been for the sustained efforts of Djebbar, in particular.[3300] The role of this region is central as it was the place through which passed most of the learning from East to West; and the links between the Maghrib and Spain are all too obvious.[3301] It remains crucial to determine when and how mathematics, in its diversity, transferred from East to West, what is distinctly eastern, and what is western, and in this respect answer once for all some issues such as that of the numerals, for instance.

[3299] M. Meyerhof: Science and Medicine, in The Legacy of Islam, op cit, pp 311-55, at p. 332. There is no evidence that such works have undertaken since Meyerhof made that observation, and this reinforces the need to go into the bulk of Muslim science that is still left untouched.
[3300] See also: Ibn al-Banna', Ahmad b. Muhammad: *Talkhis a'mal al-hisab*. Edited by M. Souissi. Tunis: (Université de Tunis, 1969).
[3301] J. Vernet (1978); J. Vernet and J. Samso (1981); J. Samso (1992) in A. Djebbar: *Mathematics*; op cit.

MEDICINE AND RELATED SCIENCES

Most works on the history of any science hardly, if ever, devote more than a few pages to the Islamic role, a few paragraphs being the rule. What is written is generally that such Islamic science was copied from the Greeks. The same historians also write that fanatical Islamic Orthodoxy harmed sciences, and persecuted scholars and left a climate of fear that hindered the growth of such sciences. This generalised approach tending at distorting, and belittling Islamic science is strongly present in the history of medicine. The first heading will run through some of its aspects, and then the following headings, with facts, will show how Western history of Islamic medicine, a handful of exceptions aside, is moribund and fundamentally corrupt, at the same time.

1. The Generalised Distorted Picture of Islamic Medicine:

The first generalised problem amongst Western historians is a failure to acknowledge Islamic accomplishments, and demeaning, and even suppressing them as much as possible. One goes through most works on the history of medicine, and however large some of them are, the best devote three to four pages to the Islamic period, generally repeating the aberrations found in their predecessors or contemporaries, especially amongst modern historians. Underwood, in his history of medicine and medical practice, in two large volumes, devotes not a single page to Islamic medicine, as if the Muslims never knew of, or wrote on, the

subject.[3302] Some works deliberately erase any Islamic accomplishment, even when they are supposedly explaining the role of Islamic medicine. Anything published today on Islamic medicine by Western scholars, with one or two exceptions aside (Jacquard, Micheau, for instance), in reality aims at suppressing Islamic accomplishments attributed by older scholars to Muslims, these modern scholars then re-attributing such accomplishments left and right to others, ending up confusing the history of the subject. Nagamia, for instance, notes how:

> 'Historians of medicine have erroneously suggested that the science of anatomy during the Islamic era was rudimentary, and did not progress much further than the discoveries already made and described by the Greeks. It was popularly held that Islamic physicians did not challenge the anatomic concepts of the ancients, partly because of the "religious proscription" against dissection, and thus, lacking in their own observations, they relied heavily on the observations of Galen, Aristotle, Paul of Aegina, and other Greek sources. However, after recent discoveries of manuscripts by an Egyptian physician, al-Tahtawi, that had been hitherto un-scrutinised, it would appear that Islamic physicians not only possessed an excellent knowledge of anatomy, but that they added some challenging new concepts that were revolutionary to the understanding of the day of the anatomical concepts laid down by the Greeks. The example that is now well-known is the discovery of the lesser or pulmonary circulation by Ibn al-Nafis (1210-1288), who suggested that there existed a pulmonary capillary bed where the blood was purified before being brought back by the pulmonary artery It ought also to be mentioned that Ibn Masawaih (777-857) had, with the special permission of the Caliph, built a house on the banks of the river Tigris where he dissected apes to learn their anatomy, and extrapolate from those results what information he could that would shed 1ight on human anatomy. Al-Zahrawi (936-1013), in the surgical section of his book *al-Tasrif* also offers his comment on anatomy.'[3303]

If and when historical facts prove a strong Muslim scientific influence in any subject or area, Western historians typically then demean their value

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[3302] E. A. Underwood, ed.: *Science, Medicine, and History: Essays on the Evolution of Scientific Thought and Medical Practice*, 2 vols (Oxford University Press; 1953).
[3303] H.F. Nagamia: An Introduction to the History of Islamic Medicine; *Islamic Culture* (1999); pp. 1-20; at p. 14.

as much as they can, such as by stressing their negligible and even negative role. Here, we are back to the sort of instances cited in part one, whereby, according to Western historians, Muslim cities are not cities, hospitals are not hospitals, military victories mere slaughter of enemy patrols, or even of shepherds, and so on and so forth. Thus, with regard to Muslim medicine, and the rise of Salerno, the first medieval university, for instance, Rashdall and his followers, that is the near entirety of Western scholarship, after explaining to us that Muslim universities were not universities (even if Western universities came centuries after the Islamic, adopting their organisation, and rising and thriving on Islamic learning in the 12th century) tells us, quote:

> 'So far from the rise of the fame of Salerno having been due to Oriental influences, it was these influences which brought about its fall. It was the increasing popularity of the Arabic medicine in the 13th century, combined with the growth of medical faculties elsewhere, which destroyed the popularity of the more conservative Civitas Hippocratica.'[3304]

Of course, assertions such as these are historically false. First, it was not Muslim learning that destroyed Salerno, to the contrary. Salerno rose to fame not before, but precisely when it received Islamic learning in the person of Constantine the African who translated Muslim works, i.e from the late 11th century through the 12th century.[3305] Salerno was destroyed following the conflicts that took place subsequently and that involved the papacy in its war on the successors of Frederick II. The papacy was keen to destroy all aspects of Islamic influences, direct and indirect, and the conflicts with Fredrick, his legacy, and the destruction of Frederick's successors, such as slaying his heir, Manfred, and exterminating the Muslims in Sicily and southern Italy were all carried out precisely for such a purpose.[3306]

Secondly, generally Western historians praise the impact of Salerno, the mother of all Western universities, a role they tell us, acquired thanks to its reviving the Greek legacy.[3307] But now, courtesy of Rashdall, the

[3304] H. Rashdall: *The Universities in Europe in the Middle Ages*; new ed by F.M. Powicke and A.B. Emden 3 vols (1936); vol I; p. 75.

[3305] C. Burnett: *The Introduction of Arabic Learning into England;* The Panizzi Lectures, 1996 (The British Library, London, 1997), p. 23.
See also: Constantine the African and 'Ali ibn al-Magusti: *The Pantegni* and related texts, ed C. Burnett and D. Jacquard, Leiden, 1994.
J. W. G. Wiet et al: *History*; op cit; p.205. W. Durant: *The Age of Faith*, op cit; p. 457.

[3306] J.P. Lomax: Frederick II, His Saracens, and the Papacy, in *Medieval Christian Perceptions of Islam,* Edited by J.V. Tolan (Routledge; London, 1996), pp. 175-97.
C. Waern: *Medieval Sicily* (Duckworth and Co; London; 1910).

[3307] Such as:

supposed expert on the history of universities, we read that it collapsed because of Islamic influences elsewhere. We are left confused on the particular role of Salerno, and its impact in the rise of higher learning.

Thirdly, when we examine the role of Salerno, we find that it rose to prominence precisely following the arrival of Constantine the African from Tunisia.[3308] He reached the south of Italy loaded with a cargo of Islamic medical books from the university of Al-Qayrawan.[3309] Constantine translated these books into Latin, and soon after these translations, Salerno rose to prominence in the field of medical studies, and gave birth to all other medical faculties of the Christian West.[3310]

Finally, Rashdall is wrong, for any examination of modern medical learning, in all its aspects, as this chapter will amply show, and as any person can check, is based on Islamic learning, a learning that was inherited primarily in the 12th-13th century, and continued for centuries after, and went on to dominate Western learning until the 18th century.

One of the most common ways of demeaning the Islamic contribution to the subject, as with other sciences, is, of course, the usual assertion that Islamic medicine is a mere reproduction of the medical lore of its Greek predecessors, Galen, above all. Every single Western historian, with one or two exceptions, is at great pains to open his/her section on any aspect of Islamic medical sciences by highlighting its Greek nature. Every author insists that Muslim medical sciences derive principally from the translation and adaptation of Greek works; any limited reference or resemblance with something Greek is widened to include the whole science or subject, and not once would a historian praise something Islamic on its own merits. Hence, looking at some instances, taken at random, we read from Dols, for instance:

> 'In the ninth century the study of plants was greatly influenced, in both form and content, by the translation of Greek texts, especially Dioscorides' *De materia medica*, Galen's *De simplicibus*, the pseudo-Galenic *De plantis*, and classical

B. Lawn: *The Salernitan Questions* (Oxford at the Clarendon Press, 1963).
L.G. Ballester: Introduction: in *Practical Medicine from Salerno to the Black Death*. Ed L.G. Ballester et al (Cambridge University Press, 1994), pp. 1-29; pp 23 fwd.
J. D. Breckenridge: The Two Sicilies; in *Islam and the Medieval West*; S. Ferber Editor; A Loan Exhibition at the University Art Gallery (State University of New York; 1975), pp 39-59. at p. 49.

[3308] See: M. Mc Vaugh, 'Constantine the African,' *Dictionary of Scientific Biography*, 3: pp. 393-5.

[3309] W. Durant: *The Age of Faith*; op cit; p. 457

[3310] M. Meyerhof: Science and medicine in the Legacy of Islam; 1st ed, op cit, p. 351.

agricultural works. The translation process also made available the pseudo-Aristotelian *De plantis*, a work on the physiology of plants. This last treatise raised philosophical questions about the nature of plants that were pursued by the Ikhwan al-Safa (Brethren of Purity), Ibn Sina, Ibn Bajja, and others.'[3311]

Al-Zahrawi's surgery, which will be considered in great length further on, is supposed to have been mainly Greek. Hence, Campbell (referring to other Western sources) reminds and insists that:

'His (Al-Zahrawi's) surgical tracts, which were translated into Latin by Gerard of Cremona, are divided into three books, and are founded on Paulus Aegineta.[3312] ... The second book, which is on general surgery, is largely a transcription from Paulus Aeginata... the third book is on fractures, luxations, obsterics... August Hirsh says that the obstetrics of Al-Zahrawi was based on Paulus Aeginita.'[3313]

Campbell concludes:

'Thus, it will be seen that this important surgical work by Albucasis (Al-Zahrawi) was founded on the surgery and obstetrics of a Paulus Aeginata, and the anatomy (which he obtained through Rhazes) on Galen.'

Back to Dols, again, this time on the hospital institution:

'The hospital was perhaps the most conspicuous institution of Islamic charity and became signal feature of the major Middle Eastern cities the medieval period. In this matter, as in many others, Islamic society was heir to Hellenistic culture. Christianity had successfully established xenodochia (literally "houses for strangers") in the Byzantine Empire from the early fourth century; subsequently they were created throughout the East and along the Mediterranean littoral. This was the root from which the civilian hospital system developed.

Though usually the abode of the sick, the xenodochium also aided the poor, wayfarers, and orphans. The early Christians regarded the care of the sick as a special duty; the earliest account of a Christian service outside the pages of the New Testament (ca. 150) shows that it was the custom to take a collection every Sunday for "orphans, widows, those who are in want owing to

[3311] M.W. Dols: Herbs; Middle Eastern; *Dictionary of Middle Ages*; op cit; vol 6; p. 185.
[3312] M. Neuburger; History of Medicine; Vol 1; p. 366; J.H. Baas: Outlines of the History of Medicine.; p. 231.
[3313] D. Campbell: *Arabian Medicine, and its Influence on the Middle Ages* (Philo Press; Amsterdam; 1926; reprinted 1974), p. 86.

sickness or any other cause, those who are in prison and strangers who are on journey" (Justin Martyr, First Apology, ch. 67).

Similarly motivated, the Muslims established comparable facilities in their newly created empire.'[3314]

On the Islamic medical impact, and from the foreword on Whipple's work on the history of medicine, we read:

'Finally, near the end of his life, he (Whipple) was given an opportunity to return to the region he loved so well-this time as a medical historian, in search of the ancient medical schools and hospitals in the Middle East, through which the traditions of Graeco-Roman medicine were passed on to the Arabs and ultimately by them to Europe.'[3315]

These and similar statements, asserting that Islamic medicine is a mere reproduction of its Greek counterpart, is generalised amongst Western historians. The rest of the chapter will deal with this kind of fallacy. Most Muslim medical findings and breakthroughs, as well as methods and approach, will be shown to be completely original, and bearing little in common link with the Greek counterpart. This chapter will also show how Muslim medical scholars and practitioners constantly refuted and reformed Greek medicine. More importantly, it ill be shown how the medicine the Muslims passed on to the Christian West was totally different from the medicine bequeathed by Greece.

A much graver assumption relates to an issue that will be largely examined in the final part of this work, a generally held opinion by Western historians that all problems of Islamic science, whatever their nature, including the decline and decadence of science, were caused by the faith of Islam. Here the culprit chosen (there could have been tens more) is Freeland Abbott, who states:

'Al-Razi was a ninth century Persian philosopher and physician. He was the first to give accurate clinical accounts of smallpox and measles and he made extensive studies of the human eye. His reputation as a physician was deservedly great during his lifetime but, like many other Muslim scientists, Razi made little impact upon his world. To the Muslim community, deeply influenced by traditionalist thought, his discoveries seemed irrelevant and unnecessary. The community held that the important thing in life

[3314] M.W. Dols: Hospitals and Poor Relief; *Dictionary of Middle Ages*; op cit; pp. 290-5; at p. 290.
[3315] A. Whipple: *The Role of the Nestorians and Muslims in the History of Medicine*. Microfilm-xerography by University Microfilms International Ann Arbor (Michigan, U.S.A. 1977), Foreword by C.A. Janeway.

was not to improve one's well being but to get to heaven when one's earthly life was over. And the road to heaven was chartered as a clear path. That path, preserved and sharply defined by the traditionalists, included prayers and creed but it did not include so living as to avoid measles and smallpox. Razi's discoveries were nonessentials so far as the purpose of life was concerned, and this being so, they were ignored and even attacked.'[3316]

This matter of this obscure and obscurantist faith destroying science will receive ample space in the third part to warrant comment here.

Bringing the previous two elements together (i.e that Islamic medicine is a mere plagiarism of Greek medicine and the Islamic hostility to medical practice) is J. Christoph Burgel ('Like most other specialists on Arabic and Islamic medicine').[3317] Like most such 'specialists,' indeed, he champions the false and the ridiculous. His argument deserves to be examined in detail. Thus, he says:

'All these literary forms of medical topics had been cultivated by the Greeks and were taken over by the Arabs, who 'inherited,' them by translating hundreds of Greek sources into Arabic. This work was done by a relatively small number of scholars, mainly during the ninth century. It cannot be overestimated as one of the great achievements in the history of the human spirit.

The Arabs took over the Galenic system in its totality and clung to it until the European impact in the 19th century. Their own contributions, e.g Razi's famous description of small pox and measles, were based on this very system.'[3318]

Burgel briefly comments on Muslim hospitals, before concluding on their standards:

'We are told that the maniacs were treated in these rooms, but this should not be confounded with the modern standard treatment of mental diseases, as is sometimes done. Recourse to chains and whipping in the treatment of the insane was a normal proceeding of the time.'[3319]

'On the whole,' he concludes, 'and with only few exceptions, the contribution of the Arabs and the Islamic Middle Ages to the

[3316] Freeland Abbott: *Islam and Pakistan* (Ithaca; New York; 1908), pp 25-6.
[3317] J. Christoph Burgel: Secular and Religious Features of Medieval Arabic Medicine; in *Asian Medical Systems, A Comparative Study*; edited by C. Leslie (University of California Press; 1976), pp. 44-62; at p. 44.
[3318] Ibid; p. 45.
[3319] Ibid; p. 49.

development of medicine do not reside in sensational discoveries. One of the rare exceptions is a rather correct description of the pulmonary circulation by Ibn Nafis about four centuries before the European discovery of it by William Harvey. Progress was also made in the diagnosis and description of certain diseases. The main achievements of medieval Arabic medicine must, however, be looked for in five fields: systematisation, hospitals, pharmacology, surgery, and ophthalmology.'[3320]

These accomplishments were, however, according to Burgel, under Galenic influence.

Just as it rose by adopting Greek science, Islamic medicine is said to have declined because it abandoned its Greek model and turned instead to its faith; a faith which gave rise to forces of obscurity, which destroyed the Greek heritage. Hence, Burgel goes on:

'The Mongols played their part, destroying hundreds of libraries, and probably dozens of hospitals. They started by destroying the Adudi hospital in Baghdad, which had prospered for more than two and half centuries. But a society incapable of resisting nomadic invaders must have been largely rotten, at least in its leading circles, and the Mongols cannot be charged with having destroyed Islamic civilisation and even science. On the contrary, after having won power, they encouraged and revitalised science and culture on a large scale.'[3321]

The main reason for Islamic decline, he insists, was that:

'Rational thought had several renowned enemies, some of whom could trace their origins to antiquity. I refer to astrology, alchemy, magic-and finally, of Islamic origin, the so-called Prophetic medicine. These four were looked upon as sciences by the great majority , and even most of the scholars. Nevertheless, they were hothouses of irrationalism, the rational disguise making them only the more harmful.'[3322]

In the mind of many pious Muslims, he adds

'Suffering was a religious virtue and disease a sign of holiness. The Prophet was reported to have said: 'he who dies on a sickbed, dies the death of a martyr and is secure against the inquisition of

[3320] Ibid; p. 52.
[3321] Ibid; p. 54.
[3322] Ibid.

the tomb.'[3323] This conviction was incompatible with the resort to medical cure.'[3324]

Burgel then quotes a Hadith by the Prophet, which exhorts people to treat the sick person, but assert that such Hadith has been amplified by Muslims who want to amplify the scientific side of Islam, explaining that:

> 'This latter amplification is a good example of the way that Hadith developed by being used, and forged!'

He adds:

> 'The sentence (by the Prophet) ''Science is two fold: the science of the bodies and the science of religion.'' This saying is still quoted by Muslims who want to prove the favourable views of Islam of learning and science.
>
> An affirmative attitude towards the use of medical treatment must not, however, be confounded with a favourable view on rational scientific medicine. On the contrary, prophetic medicine was meant to be the religious counterpart of the suspected Galenic medicine.'[3325]

Then he comments on the Prophet's saying that the stomach is the source of poor and good health:

> 'The basic theory of Bedouin pathology was evidently that all diseases were ultimately caused by a disorder in the stomach, by wrong nutrition or ingestion. Reasonable nutrition was therefore the chief prophylactic against falling ill, and diet the best remedy for sickness. However, the leading role this saying came to play in medical literature might be based on the fact that it was closely related to the central Greek idea of symmetry.'[3326]

But, he adds:

> 'The enterprise of mixing Galenic with Prophetic medicine did not increase critical thinking: it introduced magic and religious superstition into the rational system of education.'[3327]
>
> 'Later, with support from the orthodox and the authors of Prophetic medicine, magical healing developed into gross forms of religious sorcery.'[3328]

And, he concludes:

> 'This judgment would sound too severe if it had not already been made by a Muslim scholar in the Middle Ages. No doubt many

[3323] Cf. the article Shahid in the *Shorter Encyclopaedia of Islam*; (1953).
[3324] J. Christoph Burgel: *Secular and Religious Features*; p. 55.
[3325] Ibid; p. 56.
[3326] Ibid; p. 57.
[3327] Ibid; p. 58.
[3328] Ibid.

> physicians of the rational party were well aware of the dangers of prophetic medicine. But we seldom come across an open criticism, for physicians, especially if they were non Muslims or notoriously rationalists, feared the orthodox reaction if they were to put forward too candid a criticism of this part of the holy tradition. We may be sure, however, that much of the indirect criticism referring to shameful intruders who had stolen into the art and pretended to have knowledge of things in reality they knew nothing about, was directed against those who espoused Prophetic medicine.'[3329]

The following outline, in its various headings, will show how ridiculous are the views of Burgel and those of the hordes of others of similar nature. But, briefly, here:

-First beginning with one of the latter points he makes, asserting that when the Prophet talks of the role of diet as a foundation of afflictions/well being, it is as if the Prophet read Galen, which he never did or even knew about, or cared about; Galen, in fact, was discovered by the Muslims centuries after the Prophet.

-Secondly, earlier, Burgel says that Muslims in the 9th century translated hundreds of Greek works. It was not hundreds but tens of works.

Thirdly, Burgel makes generalised assertions not once providing a foot note, or precise piece of evidence.

Fourthly, with regard to the medicine of the Prophet, the best known Islamic medieval author advocating it is the Syrian Ibn Qayyim al-Jawziyya (b. 1262- d.1350), and who was a jurist by training. Even he, Ibn Qayyim, although preaching ardently Prophetic medicine, insists that reliance on specialised medical knowledge was also necessary, and that a good Muslim should resort to a physician.[3330] To pound this point home, he, Ibn Qayyim referred to the Prophet's saying, that when a disciple asked the Prophet what to do about his illness, the Prophet ordered him to take himself off immediately to a qualified medical doctor.[3331] Prophet Mohamed also clearly said:

> 'There is no ailment for which God has not created a cure'[3332]

Fifthly, what gives Burgel the authority, without proof, to assert that the Prophet's sayings which call for the treatment of the sick were forged, or

[3329] Ibid; p. 60.
[3330] S. Watts: *Disease and Medicine in World History* (Routledge; 2003), p. 52.
[3331] Ibid.
[3332] Sahih al-Bukhari (The most trusted piece of Hadith collection in Islam).

propagandist opinions added later to improve the view of Islam. The fact is, there is no need for people to forge the sayings of the Prophet on medical healing, for his sayings in this field precisely correspond and complement others he made in encouraging and exhorting Muslims to seek knowledge on repeated occasions. For instance, one of his Sayings 'Hadith', quoted by Cumston in his *History of Medicine*, says:

> 'Science is the remedy for the infirmities of ignorance, a comfortable beacon in the night of injustice. The study of the sciences has the value of a fast; the teaching of them has the value of prayer; in a noble heart they inspire the highest feelings and they correct and humanise the perverted.'[3333]

The fact also is that the Qur'an, as seen in the first part, and as will be amply shown in the final part, urges and exhorts Muslims to learn and ponder, and privileges those who know over those who do not, as seen already, the Qur'an acts as a direct inspiration for many sciences. Arnaldez and Massignon note how the Qur'an preached knowledge, not necessarily religious laws only, for Islam never made a clear cut distinction between the sacred and profane.[3334] Thus, when Ibn Rushd, for instance, wrote that the Qur'an invites men to observe nature and to seek rational knowledge, he expressed the opinion of all Muslim scholars that the earth was given to man for constant and reverent study.[3335] The many Hadiths by the Prophet with regard to sciences, especially those concerning medicine in general, and remedies in particular, were used by Muslim scientists and philosophers to base many of their dicta and actions, Arnaldez and Massignon.[3336]

Finally, if Burgel, and the countless others who consider themselves scholars, believe that Muslims, the lettered and the illiterate are stupid enough to follow a faith of obscurity, they are mistaken. They ought to know that as we read in the Qur'an:

> 'It is those of his servants who have knowledge who stand in true awe of God' 35:28.

But, let's suppose for an instant that Burgel and the countless others holding the same views as his were correct in their assumptions. Let's suppose Islamic medicine could only thrive because it was inspired by the Greeks. Could they then explain about all the other sciences and manifestations of civilisation, especially those which had no Greek

[3333] C.G. Cumston: *The History of Medicine* (London; 1926), p. 186.
[3334] R. Arnaldez-L.Massignon: Arabic Science; op cit; p. 386.
[3335] Ibid.
[3336] Ibid.

antecedent of any form. How about paper making, libraries, dam construction, irrigation, trade, commerce, banking, etc. They thrived at the same time as medicine, and they had nothing Greek behind them, or in them.

With regard to the point on the persecution of scholars, history is here a witness: no scientist was ever burnt at the stake in Islam. Scientists, in fact, thrived in their thousands as this work and many others show. Scientists were burnt on the stake, in their countless numbers, together with women, 'witches,' dissenting priests, 'heretics,' Indians (in the Americas), in the lands which harboured the ancestors of our modern historians.[3337]

With regard to sorcery, magic, saints, etc, and again historical evidence is here to prove as Draper puts it that, whilst:

> 'The Christian peasant, fever stricken or overtaken by accident, tried to the nearest saint shrine and expected a miracle; the Spanish Moor relied on the prescription or lancet of his physician, or the bandage and knife of his surgeon.'[3338]

Fatalism and hostility to science, this author, as a Muslim, never found anywhere in the Qur'an or Hadith and as a historian, he never found in Islamic history. So where, one asks, is this fatalism and Islamic hostility to science one keeps finding in the writing of these 'specialists' on Islam and its civilisation. And if Islam was fatalistic, and was hostile to science, where did all the breakthroughs that follow come from at the time the Islamic 'theocratic' state was so powerful?

2. Dominant Aspects of Muslim Medicine:

Under the Muslims, medicine departed from the narrow focus of its predecessors, a few individuals such as Galen and Hippocrates, to become a universal science, attracting the interest of hundreds, not to say

[3337] See, for instance:
R. Garaudy: *Comment l'Homme devient Humain* (Editions J.A, 1978), pp.276-7.
W. Howitt: *Colonisation and Christianity* (Longman; London), 1838.
J.W. Draper: *History of the Conflict Between Religion and Sciences* (Henry. S. King & Co; London; 1875).
D E. Stannard: "Genocide in The Americas" in *The Nation*, October 19, 1992 pp. 430-4.
[3338] J.W. Draper: *History*, op cit, vol II, p. 40.

thousands of scholars.[3339] The authors of repute alone numbered over 400.[3340] The fame of the medical colleges of the Orient spread rapidly throughout the world, and attracted the ambitious of every creed, Christian, Hebrew and Muslim.[3341] In the 11th century there were more than six thousand students of medicine in the schools of Baghdad alone,[3342] possibly an exaggerated figure, but even if by ten times, it still expresses the mass interest and spread of medical learning and practice in the Islamic world. In the city of Baghdad, in the year 931, a board for the medical practitioners was established by royal decree, and all those who practised medicine had to pass the examination. 860 candidates appeared for the examination, indicating at least 1000 practising physicians in Baghdad.[3343] The population, whether rich or poor, also found in the hospitals places and means for healing.[3344] The Mansuri hospital in Cairo, founded in 1284, accommodated 8000 people in its separate wards for different illnesses and for both men and women. It had also a large administrative staff, a dispensary, a mosque, a library and facilities for teaching.[3345] And more appropriately, its constitution read:

> 'Its duty is to give care to the ill, poor men and women until they recover. It is at the service of the powerful and the weak, the poor and the rich, of the subject and the prince, of the citizen and the brigand, without demand for any form of payment, but only for the sake of God, the provider.'[3346]

That Muslim medicine was flourishing is obvious in the countless works on the subject, and also in their size and impact. Ibn Sina's *Qanun* (Canon of Medicine) is one of the most voluminous works ever published; but also, according to Meyerhof, a masterpiece of systematisation.[3347] Al-Razi wrote more than 100 books covering a variety of diseases and medical subjects.[3348] His *al-Hawi* (the Comprehensive Book) or *Continens* as known by its Latin name, is an encyclopaedic work on medicine and

[3339] N.L. Leclerc: *Histoire de la Medecine Arabe*; 2 vols (Paris; 1876).
[3340] R.H. Major: *A History of Medicine;* 2 Volumes (Blackwell; Oxford; 1954), vol 1; p. 232.
[3341] S.P. Scott: *History;* op cit; vol 3; p. 509.
[3342] Ibid.
[3343] R.H. Major: *A History of Medicine;* op cit; p. 232.
[3344] N.L. Leclerc: *Histoire de la Medicine*; op cit; A. Isa Bey: *Histoire des hopitaux* (Imprimerie Paul Barbey, Cairo, 1928).
[3345] W.M. Watt: *The Influence,* op cit, p. 37.
[3346] A. Isa Bey: *Histoire des hopitaux;* op cit; *p.* 151.
[3347] M. Meyerhof: Science and Medicine, op cit, p. 329.
[3348] G.M. Wickens: The Middle East, op cit, p 116.

surgery in 25 volumes.[3349] No complete Manuscript of it exists, but it can be found split in many parts in libraries world-wide: three volumes in the British Museum, three in the Bodleian, four or five in the Escurial (Madrid), others at Munich and Petrograd and some abridgments in Berlin.[3350] Ibn al-Nafis (1210-1288) wrote among others *Kitab al-Shamil fi Sina'at al-Tibiyya* (Comprehensive Book on the Art of Medicine), a book intended to be in three hundred volumes, of which he only managed to publish eighty.[3351] Manuscripts of this work can be found in Cambridge University Library, the Bodleian (Oxford), and al-Muthaf al-Iraqi (Iraq). Equally huge and richly diverse are the works of Ibn Zuhr, Ibn Rushd, and many others.

The impact of these works is obvious in their lengthy use and repeated editions. The Canon of Ibn Sina, for instance, first translated into Latin in the 12th century, remained taught in Europe until the 17th century. In the last thirty years of the 15th century, it was issued sixteen times: fifteen in Latin and one in Hebrew.[3352] In the 16th century, it was edited 21 times; on top of commentaries in both Latin and Hebrew.[3353] Al-Razi's *Al-Hawi* was translated on the order of Charles of Anjou in the 13th century by Faraj Ibn Salim (Faragut), and was propagated in numerous manuscripts in the following centuries.[3354] Latin versions of Al-Razi were published at Milan in 1481, at Venice in 1483, 1490, 1493; Bergamo 1497; 1498; 1500; 1506; 1509; and 1510, and at Lyons in 1510. Other Latin versions appeared in Basle (1529; 1544); Strasbourg (1549); Basle London (1747), Gottingen (1781), and elsewhere. In addition his works were translated into Greek (Paris, 1548), French (Paris, 1763), Italian (Venice); and English (1848).[3355] The last cited translation into English being of his treatise On Small pox and Measles, undertaken for the Sydenham Society by Greenhill, appearing in 1848.[3356] Al-Zahrawi's *tasrif*, translated as *Liber Servitoris* by Gerard of Cremona (in the 12th century), had many editions in Venice (1497), Basel (1541) and Oxford (1778), and for centuries, it was the manual of surgery in Salerno, Montpelier and other early medical schools of Europe.[3357]

[3349] R.H. Major: *A History of Medicine;* op cit; vol 1; p. 238.
[3350] E.G. Browne quoted in A. Whipple: *The Role*; op cit; p.39.
[3351] A.Z. Iskandar: Ibn Al-Nafis, in *Encyclopaedia*; (ed H. Selin); op cit; p.410.
[3352] R.H. Major: *A History of Medicine;* op cit; vol 1; p. 246.
[3353] M. Meyerhof: Science and Medicine, in *The Legacy of Islam* (ed T. Arnold and A. Guillaume,) op cit; pp 311-55, at pp 329-30.
[3354] M. Meyerhof: Science and Medicine, pp 324-5. N. Daniel: *The Arabs;* op cit; p.305.
[3355] D. Campbell: *Arabian Medicine;* op cit; pp. 70-1.
[3356] W.A. Greenhill tr of: *A Treatise on the Smallpox and Measles by Rhazes* (Sydenham Society; 1848).
[3357] G. Sarton: *Introduction;* vol 1; op cit. 534.

It is of little value to discuss even the most important subjects addressed by Muslim authors, a whole encyclopaedia being necessary for this. But briefly, here, the most succinct outline looking at some subjects, by some authors, will illustrate for us how the Muslim scholars, by their works, created the first proper medical textbooks, in a format which would be recognisable to medical students anywhere in the world today,[3358] and how Islamic medicine covered many subjects hardly, if ever considered by the Greeks, beginning with Al-Madjusi (d. 994), who, in his *Kitab al-Malaki (Liber Regalis),* describes eczema, scabies, miliaria rubra, miliaria alba, favus, pediculosis, seborrhoeic dermatitis, alopecia areata, lupus vulgaris, leprosy, filariasis, smallpox, chickenpox, measles and erysipelas, giving the differential diagnosis of each with the appropriate treatment.[3359] The second Ibn Zuhr (the Latin Avenzoar) (b. ca. 1091- 1094) wrote *Kitab al-taysir fi-l-mudawat wal-tadbir (*Book of Simplification Concerning Therapeutics and Diet), which contains an elaborate study of pathological conditions and relevant therapeutics, the whole followed by an antidotary or formulary called *Jami'* (Collected Recipes), which is sometimes mentioned as a separate work.[3360] The *Taysir* dealt with specific medical conditions such as pericarditis, pharangeal paralysis, inflammation of the middle ear, and recommended tracheotomy for laryngeal obstruction.[3361] Ibn Zuhr is said to have been the first to suggest that patients suffering from oesophageal stricture might be fed by nutrient enemata.[3362] Ibn Sina's *Canon* discusses mineral, animal and vegetable poisons, rabies, venesection, cancer of the breast, hydrocele, tumours, skin diseases, labour.[3363] In the *Canon*, pulmonary tuberculosis is for the first time regarded as a contagious disease.[3364] Ibn Sina also gives an excellent clinical account of meningitis, differentiating from the meningismus of other acute diseases; he describes chronic nephritis, facial paralysis; pyloric senosis, ulcer of the stomach, and much else.[3365] In describing difficult labour, he says, after mentioning several procedures, 'when this fails, the forceps are to be applied and the child is to be extracted by them,' a passage, which Major insists, supplies unmistakable proof that

[3358] C.J. M. Whitty: The Impact of Islamic Medicine on Post Medieval England; *Islamic Culture*; Vol LXXIII (1999); pp. 45-57; at p. 46.
[3359] R.H. Major: *A History of Medicine;* op cit; vol 1; p. 241.
[3360] G. Sarton: *Introduction;* op cit; vol 2; p. 232.
[3361] A. Whipple: *The Role*, op cit; p.52.
[3362] D. Guthrie: *A History of Medicine* (Thomas Nelson and Sons Ltd; London; 1958), p. 94.
[3363] R.H. Major: *A History of Medicine;* op cit; vol 1; p. 245.
[3364] D. Guthrie: *A History of Medicine;* op cit; p. 92.
[3365] R.H. Major: *A History of Medicine;* op cit; vol 1; p. 245.

the Muslim physicians were familiar with obstetrical forceps.[3366] Ibn Sina also notes the effect upon health of water supply, climate, the seasons, bathing, sleep, and emotional disturbance.[3367]

The Islamic scholars completely reshaped medical writing and learning in comparison with their Greek predecessors, putting together a whole new methodology. Al-Razi, for instance, observes how Hippocrates' *Aphorisms* was disorganised, ambiguous, and unnecessarily brief.[3368] Hence, his larger, more encompassing, and more importantly, systematically constructed work, *Al-Hawi.* Islamic scholars strove to bring order to the subject, on theoretical and practical levels, the first including body matters, and the second embracing all forms of therapeutics: surgery, physical exercise, drug therapy, etc. Medicine was further subdivided into various disciplines: ophthalmology, dentistry, psychiatry, gynaecology, paediatrics, etc.[3369] In Al-Razi's *al-Mansuri,* a treatise on anatomy, each bone, muscle, or organ is described in the light of its function and purpose.[3370] Al-Madjusi's *Kitab al-Maliki* (The Royal Book*)* consists of twenty sections, ten on the theoretical principles of medicine and ten on its practice. It was the first comprehensive and methodical presentation of medicine as a whole-something which the Greeks had not attempted.[3371] Al-Qumri (fl end 10th century), and the teacher of Ibn Sina, wrote *Kitab ghina wa mana* (The Book of Life and Death) divided into three parts: internal diseases, external diseases, and fevers.[3372] Al-Zahrawi, Al-Madjusi, Ibn Zuhr, and others also make classifications of their subjects, and from the writing of Ibn Zuhr it can be seen that in his day the professions of physician, surgeon and apothecary were separated.[3373]

The training of doctors, although hardly given its due in the literature on the subject, played a crucial role in the advance of medicine. It was carried out by the apprenticeship method, and in the hospitals, where the school, if it were called that, was a part of the hospital, much as it is still done in London at the present time.[3374] In many of these hospitals, prescribed lectures were given in the large hall of the hospital. These

[3366] Ibid.
[3367] D. Guthrie: *A History of Medicine*; op cit; p. 92.
[3368] S.K. Hamarneh: Ar-Razi; op cit; p. 166.
[3369] I and L. Al-Faruqi: *The Cultural Atlas*, op cit, p 325.
[3370] G. Wiet et al.: *History*; op cit; p. 653.
[3371] Ibid.
[3372] G.Sarton: *Introduction*; op cit; vol 1; p. 678.
[3373] D. Campbell: *Arabian Medicine*; op cit; pp. 90-1.
[3374] A. Whipple: *The Role*; op cit; p. 59.

lectures consisted of the reading of a medical manuscript, and following the reading, the chief physician or surgeon asked and answered questions from the students.[3375] Al-Razi, for instance, called for high professional standards for practioners, and urged physicians to continue their education by studying medical treatises, attending lectures, and training at hospitals.[3376] He boasted that his knowledge had been acquired in hospitals and not from libraries.[3377] Bedside teaching was considered to be the most important part of the training, the students in groups following the attending physician or surgeon in his ward rounds, the more advanced students observing the doctor, then later in the day, taking the history and making an examination of the patients, and prescribing for them in the Out-Patient Department of the hospital.[3378] Only those professionals who had undertaken the required training, such as in Cairo, at the madrasa al-Barquqia, and who had submitted to examinations, which generally consisted in a commentary on an ancient medical treatise, could undertake the profession of physician.[3379] They obtained a licence to practise (*ijaza*), delivered by the head of the medical profession.[3380] Women, too, could join the profession.[3381] But all medical doctors submitted to the supervisory authority of the Muhtasib (the State Inspector), who also made them swear their professional oaths.[3382] All the writings on *hisba*, city policing, cover the rigorous inspection of doctors, bone-setters, oculists, and veterinary surgeons.[3383] The prefect was empowered to investigate the competence of the practitioners, who were expected to know certain manuals by heart, and to demand to see their medical instruments, lists of which were given in the manuals.[3384]

Ethics took a central role in Muslim medical practice. Al-Zahrawi (b.936. d.1013), recommending to his sons (i.e his students) the trade of surgeon, says:

> 'Show caution and care for yourselves and gentleness and perseverance for your patients. Purify yourselves of anything which

[3375] Ibid.
[3376] S.K. Hamarneh: Ar-Razi; in *The Genius of Arab Civilisation* (J.R. Hayes ed); op cit; p.166.
[3377] S.P. Scott: *History*; op cit; vol 3; p. 509.
[3378] A. Whipple: *The Role;* op cit; pp. 59-60.
[3379] D. Behrens Abouseif; S. Denoix, J.C. Garcin: Cairo: in *Grandes Villes Mediterraneenes;* op cit; pp. 177-203; p. 195.
[3380] Ibid.
[3381] Ibid.
[3382] Ibid.
[3383] G. Wiet et al: *History;* op cit; p. 654.
[3384] Ibid.

> you fear may cause doubt as to your religious life and your secular life; for this will perpetuate your good name and will elevate your fortunes in this world and the next.'[3385]

And:

> 'I warn you against undertaking any case in which there is any element of doubt to you; for in the exercise of the art, you will be mobbed by all kinds of persons with all manners of afflictions... let your caution be stronger than your greed and desire for gains, and do not embark upon anything of this kind unless you have positive knowledge, which you judge adequate, about the way of bringing the patient a good outcome. In treating every patient be prescient and foretell the means whereby health may be restored to him.... may God inspire you my sons, with His guidance, and grant you that you hit the mark and succeed; for it is in His hand. There is no God but He.'[3386]

The best account we have in English on the ethics of the physician is by Ishaq bin Rahawi *'Adab al-Tabib,'* (On the Good Manners of the Physician) a substantial part of which was translated by Levey.[3387] The treatise has twenty chapters, which include matters such as 1. What the physician must avoid and beware of; 2. Manners of the visitors; 3. Care of remedies by the physician; 4. Dignity of the medical profession; 5. Examination of physicians; 6. Removal of corrupt physicians.[3388]

Islamic medical care was an all encompassing practice, Muslim physicians seeing their patients regularly, and even associating with them socially. They looked at all aspects of the patient's life, physical and mental, and were aware of the latter's influence on the general well being.[3389] Al-Razi, thus, called for consultation and mutual trust between skilled physicians, and favoured a family doctor practice, besides warning patients that changing doctors would waste their wealth, health, and time.[3390] He promoted psychotherapy, pointing out that hopeful comments from doctors encouraged patients and made them feel better.[3391]

[3385] M.S. Spink and G.L. Lewis: *Abulcasis on Surgery and Instruments* (The Wellcome Institute, London, 1973), p. 6.
[3386] Ibid; p. 166.
[3387] Under the title 'Medical Ethics of Medieval Islam with special reference to Rahawi's 'practical Ethics of the physician.' *The American Philosophical Society*, Vol 57, part 3, pp: 1-99 (1967).
[3388] A. Khan: Islamic philosophy and medical ethics, in *Islamic Perspective in Medicine*, ed S Athar, (American Trust Publications, Indianapolis, 1993), pp. 103-5.
[3389] M. Levey: *Early Arabic Pharmacology* (E. J. Brill; Leiden, 1973), p. 52.
[3390] S.K. Hamarneh: Ar-Razi; op cit; p.166.
[3391] Ibid.

The equilibrium of the body had the most important role, though.[3392] As Levey notes, when a person became ill, the Muslim physician's tendency was to tip the balance the other way gently by means of nutritive drugs, and when these were not effective, simple drugs were then employed.[3393] Treatment took into account the patient's temperament, diet and previous illnesses.[3394] Ibn Jazla's (b.1074) *Taqwim al-Abdan fi tadbir al-Insan* (Tables of the Body With Regard to the Physical Management of Man), for instance, is a thorough study of the very structure of the body, how its diverse parts impacted and inter-related. Health depended on 'an equilibrium of the humours,' an equilibrium which varied with the individual.[3395]

The emphasis is more on health than on disease, and near the beginning of Ibn Sina's Canon of Medicine was this:

> "I say that medicine is the science by which the dispositions of the human body are known, in order that customary health may be preserved or, being lost, may be recovered."[3396]

Ibn Massawayh (Mesue Senior) (777-857) in his aphorisms,[3397] advises the following:

> 'The constitution of living bodies is made up of numerous factors. Do not use brutal procedures which undermine the organism and attack, weaken and shake the body, so that its constitution becomes changed.' (Aphorism 26)
>
> 'Whenever possible, we must treat each organ with remedies resembling the organ's natural food; if the cure is a change of diet, so much the better.' (Aphorism 35).
>
> 'Patients whose main organs are impaired must not be given hot medicaments; you must control their diet until equilibrium is restored.' (Aphorism 61)
>
> 'The physician must copy the action of nature.' (Aphorism 64)
>
> 'In their treatment of diseases, physicians must aim to restore the body to its normal state of health, and not to perfect equilibrium.' (Aphorism 68)

[3392] P. Lory: Philosophes et Savants; with participation of H.Bellosta; in *Etats, Societes et Cultures du Monde Musulman Medieval;* edited J.C. Garcin et al; Vol 2 (Presses Universitaires de France; p.2000), pp. 371-98. p.387.
[3393] M. Levey: Early Arabic, op cit, p. 52.
[3394] P Benoit and F. Micheau: The Arab intermediary: in *A History of Scientific Thought*; M. Serres ed (Blackwell, 1995), pp 191-221; p. 208.
[3395] Ibid.
[3396] N. Daniel: *The Arabs and Medieval Europe*; op cit; p. 292.
[3397] R. Arnaldez-L.Massignon: Arabic Science; op cit; p. 418.

Ibn Butlan's (d.ca 1068) *Taqwim as-sihha* (Latin: *Tacuinum Sanitatis*,) retaining the Arabic word with the translation "regimen", begins:

> 'On the six things that are necessary to any man for the daily conservation of his health, with its corrections and operations.' These are immediately listed:
>
> "The first care of health is the preparation of the air, which affects the heart. The second is the regulation of food and drink. The third is the regulation of movement and rest. The fourth is the restraint of the body from sleep and from much watching. The fifth is the regulation of the relaxation and constriction of the humours. The sixth is regulation of the person to moderate joy, anger, fear and anxiety. So the preservation of health will be in these methods of balance, and the removal of these six from that balance makes illness, God the Glorious, the Almighty, permitting. And under each of these kinds there are many types, and many things necessary of which, God willing, we will describe the natures ... Let us invoke the help of God that He may make straight our mind, for human nature can scarcely be prevented from error…''[3398]

Diet was central in Islamic medicine, and early Islamic scholars followed the Prophet's stance that all health predicaments have their origin in diet. Abu 'Abdallah Mutammad al-Tamimi al-Muqaddasi (fl. c. 970) wrote several medical books, and most interestingly *Kitab al-murshid ila jawahir al-aghdhiya wa quwa-l-mufradat;* which, as the title suggests, is a guide toward the understanding of the substances of food-stuffs and (of) the simple drugs, on how diet affects well being.[3399] Ibn al-Wafid in his *On the Powers of Medicines and Foods*, among others, states:

> "I have put together this book on the virtues of medicines and foods, from the books of the ancients; for long have I wearied my mind with it . . . I have poured forth prayers on it that it may come near to God, the Exalted, the Glorious . . . The object of medicine is health, and according to two modes. The first is the knowledge of the complexions of the bodies of men. The second is the knowledge of medicines and foods, by the knowledge of which health is maintained in the healthy man and restored in the sick man.'[3400]

[3398] N. Daniel: *The Arabs and Medieval Europe*; op cit; p. 292.
[3399] G. Sarton: *Introduction;* op cit; vol I; p. 679.
[3400] N. Daniel: *The Arabs and Medieval Europe*; op cit; p. 292.

Ibn Zuhr of Seville in his *Teisir* also describes the methods of preparing medicines and diet.[3401] Al-Razi, too, advised his colleagues to allow patients to eat foods they preferred; and also stressed the importance of a balanced diet for the preservation or restoration of good health.[3402]
Good, appetising food was also deemed, under special circumstances, to help recovery as well captured in this anecdote narrated by Al-Zahiri who told about his visit to Damascus :

> 'I was accompanied by a distinguished and affable Persian. When he visited the al-Nuri hospital (named after the ruler Nur Eddin Zangi (d. 1173) and saw the diets, the utilities and the comforts to be found there, he decided to see for himself what being a patient was like in that hospital. He pretended illness and was admitted to the hospital. There the medical chief visited him every day and took his pulse and prescribed his diet, consisting of a variety of meats, fat chickens, candies and drinks and fresh fruits. On the third day the doctor told him that such patients were not allowed to stay more than three days, and asked him to leave.'[3403]

Just as, in its generalised form, Islamic medicine formed the foundation of modern medicine, in some specific areas it still constitutes the most powerful basis for many modern breakthroughs in the subject.

3. Defining Instances From Islamic Medicine:

Islamic medicine, in both its theoretical aspects and practical applications had a highly innovative and original character, which sharply demarked it from its predecessors and contemporaries.

Observation and experimentation played a central role in the Islamic scientific experience, and medicine was no exception. In stark contrast to the medical teachers of Europe, Islamic writers were practising physicians, who spoke from their own experience.[3404] 'He who studies the

[3401] D. Campbell: *Arabian Medicine;* op cit; pp. 90-1.
[3402] S.K. Hamarneh: Ar-Razi; op cit; p.166.
[3403] K. Ibn-Shahine al-Zahiri: *Tableau politique et administratif de la Syrie* (Paris, 1894), quoted by Issa Bey: *Histoire des hopitaux en Islam*; Dar ar ra'id al'arabi (Beirut; 1981), p. 192.
[3404] C.J. M. Whitty: The Impact of Islamic Medicine; op cit; p. 47.

work of the Ancients gains the experience of their labours as if he had himself lived a thousand years . . . but all that is written in books is worth less than the eye of experience,' wrote Al-Razi.[3405] Only the first part would have appealed to European universities: practical experience was not part of the training for physicians in Europe, who could complete a medical degree without ever having set eyes on a patient.[3406] A good instance of how observation demarcated Islamic from Greek medicine is an account by the Baghdadi doctor, Abd Al-Latif (1162-1231), who on a visit to Egypt, examined 200 skeletons, and wrote what follows:

> 'Now the inspection of this portion of the bodies (the mandible) has convinced us that the bone of the mandible is single, that there is neither a joint nor a suture. We have repeated this observation a great many times on more than 200 heads..... We shall write on this subject a treatise in which we shall report what we have seen and compare it with what we learned in the books of Galen.
> According to Galen, the sacrum and the coccyx are composed of six bones, for my part I have found that it is but a single bone..... With the exception of two cases only..... But in all I have found the bones firmly united.'[3407]

We also learn from the medieval English scholar, Adelard of Bath (fl. early 12th century), who was in the East during the first crusade (early 12th century), of 'Arab masters' and the old man of Tarsus who explained methods of dissection for the purpose of studying anatomy.[3408] This attitude was also prevalent in the western realm of Islam, as Al-Zahrawi insisted that a thorough knowledge of anatomy was indispensable to success in surgical practice, a statement which, in his day, had the merit of novelty.[3409] Centuries earlier, Al-Asmai (739-831) commented on anatomy, in his *kitab al-Khail* (On the Horse), *Kitab al-Wuhush* (on Wild Animals), and most importantly on the making of man (*Kitab khalk al-Insan*), highlighting early Islamic knowledge of human anatomy.[3410]

The same practical approach is adopted in relation to diseases. Muslim physicians recorded the subsequent course of the disease meticulously in

[3405] Ibid.
[3406] Ibid.
[3407] R.H. Major: *A History of Medicine*; op cit; p. 246-7.
[3408] L. Cochrane: *Adelard of Bath*; op cit; chapter 4. p. 34.
[3409] S.P. Scott: *History*; op cit; vol 3; p. 509.
[3410] The book of Distinction (*Kitab al-Fark*) was edited by D.H. Muller (Vienna, 1876); the book of wild animals by R. Geyer (Vienna, 1887); the book of the horse by A. Haffner (Vienna, 1895); the book of the sheep by the same (Vienna, 1896). In G.Sarton: *Introduction*; Vol I; op cit; p. 534.

order to check that their predictions had been correct, and this keeping of case histories was one of the greatest legacies of Islamic medicine.[3411] Al-Razi for instance, has left us thirty three accounts of his cases, and their scrutiny show how Muslim medicine relied primarily on practical experiment and observation.[3412] Al-Razi's approach was common to all Islamic medical scholars. Ibn Zuhr (b. ca.1091-94), for instance, was formed at the school of his father, and became an eminent practioner, with great medical experience, never relying on the Ancients' legacy, but instead, submitting everything to experimentation.[3413] He lays down experience as the sole guide to the physician, and shows himself as a man of independent observation, describing the operations for renal calculus and tracheotomy.[3414] And, as Scott points out, the methods of the professors and writers who directed the policy of the Muslim hospitals owed their efficacy and success to their rigorously practical character, and no course of treatment was approved until it had been repeatedly tested.[3415]

Investigation and observation were also obvious in the attitude towards contagious diseases, Ibn al-Khatib, a physician of Grenada, noting:

> 'To those who say ''How can we admit the possibility of infection while the religious law denies it?" we reply that the existence of contagion is established by experience, investigation, the evidence of the senses and trustworthy reports. These facts constitute a sound argument. The fact of contagion becomes clear to the investigator who notices how he who establishes contact with the afflicted gets the disease, whereas he who is not in contact remains safe, and how transmission is effected through garments, vessels and earrings.'[3416]

In this just cited instance, as in others of its pioneering aspects (some cited already), Islamic medicine was bound to come into conflict with the medicine of its predecessors. Al-Razi has already been noted for his criticism of Hippocrates' *Aphorisms*.[3417] Of Aristotle, this is what Al-Razi writes:

[3411] R. Arnaldez-L.Massignon: Arabic Science; op cit; p. 420.
[3412] Ibid.
[3413] L. Leclerc: *Histoire*; vol 1; op cit; p. 86.
[3414] D. Campbell: *Arabian Medicine*; op cit; pp. 90-1.
[3415] S.P. Scott: *History;* op cit; vol 3; p. 509.
[3416] Ibn al-Khatib: *Muqni'at al-Sa'il 'an al-Marad al-Ha'il*, ed. and tr. M. J. Muller, *Sitzungsberichte der konigl.bayer. Akademie der Wissenschaften zu Munchen*, vol ii (Munich, 1863), pp 6-7, 8-19 .
[3417] S.K. Hamarneh: Ar-Razi; op cit; p. 166.

> 'We observe that you endow nature with the same attributes as living beings: choice, knowledge and wisdom, because you claim that nature acts always with wisdom and fitness; that it aims towards a goal, that it does nothing aimlessly, creating the eye of an embryo so that the child might see... that it sets all things in their right places, organising them perfectly, forming the foetus in the womb and then guiding its development most delicately towards perfection; also that it governs man, lends him health, dispels his diseases, since as Hippocrates has said, nature is the physician of all our ills. And yet, you say that nature is inanimate and without life.... Without capacity of choice, without knowledge, which is an evident contradiction and a manifest absurdity.'[3418]

In *Kitab Al-shukuk al Jalinus* (Doubts on Galen,) a work considered lost in its original, but found by Kraus,[3419] Al-Razi refutes Galen substantially.[3420] Al-Razi says:

> 'Indeed, it is painful for me to oppose the one (Galen) who, amongst all men, has gifted me with goodness and has been most helpful, and by whom I was guided, and whom I followed... However the art of medicine is a philosophy, which does not include acquiescing to what the leaders (of school) say: no blind acceptance of their opinion, nor favourable treatment (of which they will benefit), no renouncing either to a profound examination of what they hold.'[3421]

Every other Muslim medical writer was also critical of Galen.[3422] Al-Madjusi (d. 994) in Kitab al-Malaki is very critical of Hippocrates, whom he finds too concise, and therefore sometimes obscure; of Galen, finding him too verbose, and of Paul of Aegina who was neglectful of surgery and anatomy.[3423] Ibn al-Nafis reconstructed the theory of the lesser circulation of the blood exactly in refutation of Galen.[3424] Al-Biruni, for his part, blamed Galen for his excessive credulity when he reports the story of the snake queen whose sight or hiss caused immediate death: 'I should like to

[3418] Al-Razi: *Opera Philosophica*; ed. P. Kraus; I; p. 120 in R. Arnaldez-L.Massignon: Arabic Science; in *Ancient and Medieval Science*; op cit; pp. 391-2.
[3419] S. Pines: *Studies in Arabic Versions of Greek Texts and in Mediaeval Science* (The Magnes Press, Brill, Leiden, 1986), Razi Critique Galien pp 256-63; at p. 256.
[3420] S.K. Hamarneh: Ar-Razi; op cit; p. 166.
[3421] S. Pines: *Studies*; op cit; p. 257.
[3422] See N.L. Leclerc: *Histoire de la medecine Arabe*; op cit.
[3423] R.H. Major: *A History of Medicine*; op cit; p. 241.
[3424] M. Meyerhof: Ibn Nafis and his theory of the lesser circulation. *ISIS* 23 (1935). Pp.100-20.

know,' al-Biruni asks, 'who could have told Galen about her habitat and qualities, if all who looked at her died.'[3425]

Al-Zahrawi (d. 1013) is also extremely critical of Greek surgery, whose deficiencies he highlights repeatedly. He refutes Greek surgical methods and techniques, such as in the repair of fractured ribs, the methods of stretching the belly of the patient and pushing the fracture; or that a cupping vessel should be applied to the place; or that wounds with fracture be bandaged (which can cause death by ulceration or defluxion.)[3426] He remarks with regard to cauterisation, for instance:

> 'The Ancients have stated that cauterisation with gold is more effective than with iron. They said that on account of the temperateness of gold and its noble character. They also stated that the site of cauterisation does not become purulent, but that is not absolutely so, for I myself have experience of that and have found that it happens in some cases and not in others. Cauterisation with gold is indeed better and more successful than with iron, as they say, except that when you are heating the gold cautery in the fire, because of its redness you cannot be sure when it has reached the desired temperature. In addition to this, gold cools very quickly, and if you overheat it it melts in the fire, heats and runs, and you will find yourself in difficulties. Therefore in our opinion cauterisation is swifter and more successful with iron.'[3427]

Islamic practice was also fundamentally at odds with contemporary Western medical practice. Muslims were pioneering in the treatment of many health problems, such as that of the insane, who benefited from great care, a consideration they little found in Western Christendom.[3428] The treatment of the mentally ill in Islam was, indeed, more humane than that seen in Europe until the 19th century.[3429] Indeed, in every respect, Western medical practice, until quite recently, lagged behind the Islamic, and the contrast was considerably sharper in medieval times. At the time, whilst in Islam we find an extraordinary outburst of secular medical learning, involving not just Muslims, but also Jews and Christians, under the Islamic state, as this chapter amply highlights, in medieval Western Christendom this was not the case. Russell even claims that the Church

[3425] Al-Biruni: Jamahir; p. 99 in F. Rosenthal: *The Technique*; op cit; p. 55.
[3426] M.S. Spink and G.L. Lewis: *Albucasis*; op cit; p. 730.
[3427] G. Lewis: The Surgery of al-Zahrawi; *Islamic Culture* (1999); pp. 21-36 at p. 26.
[3428] D. Campbell: *Arabian Medicine*; op cit; p. 56.
[3429] R. Porter: *The Greatest Benefit to Mankind* (Harper Collins; London; 1997), Chapter on Islamic medicine; in C.M. J. Whitty: The Impact; op cit; p. 48.

retarded the progress of medical science,[3430] the early Christians going as far as denying to physicians the power of healing, and the view was that many diseases were sent as punishments for sin.[3431]

Medieval Western medical practice was quite primitive, some of its common methods of treatment for practically every ailment being bleeding by leeches or at times by the use of the knife, even in the case of warriors weakened from loss of blood.[3432] The contrast with Islam was visible in the East during the crusades, where Frankish and Muslim practice came head to head as seen through a number of instances narrated by Usama Ibn Munqidh, such as the Franks carrying out unnecessary amputations leading to the death of patients, applying salt on open wounds, etc.[3433] And whilst Muslim writers such as Ibn Zuhr of Seville wrote against astrology and medical mysticism,[3434] in Western Christendom, magic charms and curious drugs were prescribed, and so was the drinking of urine for its supposedly beneficial qualities.[3435]

Even greater contrast between Islamic and Western Christian medicine applies to the invocation of saints. For each disease, in Western Christendom, Draper notes, there was a saint; thus, a man with sore eyes must invoke St. Clara, but if it were an inflammation elsewhere he must turn to St Anthony, whilst an ague would demand the assistance of St. Pernel.[3436] Guthrie offers a good outline of such healing saints, such as St Dymphna for insanity, St Roch for the plague, St Blasius the throat, St Bernardine the lungs, St Apolonia the teeth, St Lawrence the back, and so on and so forth.[3437] For the propitiating of these celestial beings it was necessary that fees should be paid, and thus the practice of religious medicine became a great source of profit.[3438] Islam, on the other hand, as Daniel correctly points out, shuns and combats beliefs in saints, relics and miracles,[3439] and the contrasting approach to this question by the two cultures came to a head in the crusade period. The Muslims became aware at first hand of crusader practices, and how relics were eagerly demanded

[3430] J.R. Russell: *History and Heroes of the Art of Medicine* (1861), p. 97.
[3431] D. Guthrie: *A History of Medicine*; op cit; pp. 84-5.
[3432] D. J. Geanakoplos: *Medieval Western Civilisation,* op cit; p.358
[3433] Usama Ibn Munqidh: *Kitab al'Itibar;* trans P.K. Hitti (Beirut; 1964).
[3434] D. Campbell: *Arabian Medicine*; op cit; pp. 90-1.
[3435] D. J. Geanakoplos: *Medieval Western;* op cit; p. 358.
[3436] J.W. Draper: *A History;* op cit; Vol II; p.122.
[3437] D. Guthrie: *A History of Medicine*; op cit; p.98 ff.
See also: J.W. Draper: *History of the Conflict Between Religion and Science*; op cit.
D. Riesman: *The Story of Medicine in the Middle Ages* (New York; 1933).
M. Bortarel: Les Saints Guerisseurs; *Paris Med.*, (1921); Vol xiii.
[3438] J. W. Draper: *A History;* op cit; p. 122.
[3439] N. Daniel: *The Arabs and Mediaeval Europe*; op cit. p.11

from the Holy land, including remains of St.Thaddeus, and the mythical King Abgar, from Edessa.[3440] In the 13th century, relics came from West to East. The arm of St Philip was sent to Acre in 1268 from Florence,[3441] where it had been adored for sixty years; and English soldiers were protected, in King Richard's time, by a 'a certain writing hanging from the neck,'[3442] better than the coat of mail, or thick pourpoint beneath.[3443] In the same 13th century, pilgrims also visited Sardenai near Damascus by special treaty with the Muslims to obtain the oil which flowed from the breast of the miraculous picture of the Virgin, painted on wood; and Tortosa with its portrait of the Virgin.[3444] Such practices drove one of the chief 'Orthodox' Islamic thinkers, Ibn Taymiyya (1263-1328), to castigate the Christian clergy for their hypocrisy, and above all their charlatanism.[3445] He said:

> 'They (the Christians) put kohl in water moving with a very slight movement, which then flowed slowly so that it ran down the picture of the virgin and came out of her eyes. People thought it was tears.'[3446]

There is also recourse to saints and marabouts for healing and much else in most modern Islamic societies even today. Watts has looked at some of these manifestations.[3447] In many parts of the Muslim world, he points out, most occult practices date from pre-Islamic times, and are relics of the Persian, Ptolemaic and Romano Coptic times.[3448] In Egypt, for instance, barren women walked seven times counter clockwise around the exterior walls of a Coptic Church.[3449] In that country, Egypt, and under strict Sunni Islam, Watts correctly notes, saints are not recognised as they are seen as primitive Christian invention.[3450] On top of this pre-Islamic factor, the general decline, which set on the Islamic land, and which will be discussed in the final part of this work pushed aside rational practice and brought about behaviours, which mirrored that Islamic decline. It is also, without doubt, Western colonisation, in its systematic efforts to unseat

[3440] Regesta; No 99; 103 in C.R. Conder: *The Latin Kingdom of Jerusalem (*The Committee of the Palestine Exploration Fund; London; 1897), p. 171.
[3441] Regesta; Nos 1361; 1365 in C. R. Conder: *The Latin;* op cit; p. 171.
[3442] Jeoff de Vinsauf, I, 49 in C. R. Conder: *The Latin;* op cit; p. 171.
[3443] C.R. Conder: *The Latin Kingdom;* op cit; p. 171.
[3444] E.G. Rey: Les Colonies Franques; in C. R. Conder: *The Latin*; p. 200.
[3445] Ibn Taymiyya: *Lettre a un roi croise*; Tr. J.R. Michot (Louvain; 1995), p. 145.
[3446] T.F. Michel: *A Muslim Theologian's Response to Christianity* (New York; 1984), 206.
[3447] S. Watts: Disease and Medicine; op cit; p. 51 ff.
[3448] Ibid; p. 51.
[3449] Ibid; p. 52.
[3450] Ibid; p. 53.

Islam, which promoted such practices as adoration of saints, so-called marabout shrines, and the likes. Dr Bodichon, one of the French theorist of colonisation of Algeria (1830-1962), for instance, held that:

> 'It matters little that France in her political conduct goes beyond the limits of common morality at times; the essential thing is that she establishes a lasting colony and that, later, she brings European civilisation to these barbaric countries..... (including through) corruption and disorganisation.'[3451]

Orthodox Islam, as can be seen in recent Islamic revivals, such as in Algeria in the 1980s, banned and fought a considerable number of such practices, which the French had encouraged during the colonial period.[3452] In Egypt, resort to saints, Watts insists, was, and is not sanctioned by the teachers of the Law and Theology of Al-Azhar.[3453] Indeed, no mufti or imam did or does anywhere else in the Sunni Islamic world, because it is simply, fundamentally at odds with the so called Orthodox-Sunni Islam.

4. Impact on the West:

Modern medicine is very close to Islamic medicine due to the early transfers of Muslim medicine to the Christian West.[3454] Jacquart's summarises the main translations of Islamic medical works.[3455] The pioneer of such translations was Constantine the African (d. ca.1087), from Tunisia initially, who spent his later life in Italy between Salerno and Monte Casino. Constantine took with him medical works of the school of Al-Qayrawan, Tunisia, including those by Ibn al-Jazzar (d.1009) and by earlier doctors of al-Qayrawan. Constantine translated such works on diets, the stomach, melancholy, forgetfulness and sexual intercourse.[3456] They had Latin translations such as *Chirurgia, 'prognostica,' 'De pulsibus,' 'De instrumentis,' 'practica*' (in 12 books), '*Liber graduum,' De stomachi et*

[3451] Cited in C.H. Favrod: *Le FLN et l'Algerie* (Paris; Plon; 1962), p. 31.
[3452] See, for instance *al-Munqidh*, and other Islamic publications.
[3453] S. Watts: Disease and Medicine; op cit; p. 53.
[3454] See: D. Campbell: *Arabian Medicine;* E.G. Browne: *Arabian Medicine* (Cambridge University Press; 1962).
[3455] D. Jacquart: The Influence of Arabic medicine in the Medieval West, in the *Encyclopaedia* (Rashed ed), op cit, pp 963-84. Table pp: 981-84.
[3456] C. Burnett: *The Introduction of Arabic Learning*; p. 23.

instestinorum infirmitatibus,' 'Liber de urina,' and a number of others.[3457] Constantine also made the partial translation of Ali Ibn Abbas (Al-Madjusi) *al-Kitab al-Malaki* into Latin called *The Pantegni*. Stephen of Antioch, a Pisan, trained in the school of Salerno, also translated in Antioch the work by Ali Ibn Abbas. This translation is found in many manuscripts with two early editions printed at Venice in 1492 and at Lyons in 1523.[3458] It was in Toledo and the South of France, though, in the 12th century and after, where the bulk of medical translations were made. Ibn al-Wafid's treatise on drugs was translated by Gerard of Cremona, and into Hebrew by Jacob of Capua. Gerard of Cremona also translated *Kitab al-Tasrif* of al-Zahrawi. The influence of *al-Tasrif* was considerable, Guy de Chauliac quotes al-Zahrawi abundantly, Roger of Parma, Lanfranc and Saliceto were also heavy borrowers.[3459] The arrangement of the work, the clear diction, and lucid explanations, all contributed to its great success.[3460] Al-Mosuli's works on eye diseases were translated into Hebrew by Nathan ha'Me'ati, who also prepared a complete Hebrew version of Ibn Sina's *Qanun*. Ibn Sina's *Arjuza* and Ibn Rushd's commentary on it were translated into Hebrew by Ayyub and Moses ben Tibbon, and from Hebrew into Latin by Armengand. Other translations during the 12th and the 13th centuries included Ibn Rushd's *Kulliyat* (Colliget: complete works)-a medical encyclopaedia- translated by Bonacossa.[3461]

The Islamic influence persisted in medicine as in other sciences for the subsequent centuries, and this despite the humanists and Classical inspired Renaissance writers, who rose in rebellion against such Islamic influence, as will be examined in the final part of this work, and as Whitty remarkably outlines.[3462] Specialist texts were heavily influenced by Islamic writers-diagnosis from urine, or ocular surgery would be examples.[3463] Islamic medicine made few contributions in relation to particular new diseases like syphilis, or the new surgical problem of dealing with gunshot wounds, but overall, the majority of people in England, for instance, were treated according to principles which were heavily, and directly, derived from Islamic medicine until at least the

[3457] D. Campbell: *Arabian Medicine*, op cit; 123.
[3458] C.H. Haskins: *Studies,* op cit, p. 131 fwd.
[3459] R.H. Major: *A History of Medicine*; op cit; p. 252.
[3460] Ibid.
[3461] For details on translations, see G.Sarton: *Introduction,* op cit; Vol 2; pp. 167 ff.
[3462] C.J. M. Whitty: The Islamic Impact on Medicine; op cit.
[3463] For example, Anon: *Here begyneth the seyuge of uryns* (London, 1525).

middle of the 17th century.[3464] Even those who could not be treated by physicians would often be given drugs which were Arabic in origin, as the Pharmacopoeia Londinensis amply demonstrates.[3465]

A major problem relating to this issue of transfer concerns the assertion found amongst mainstream historians that the translations from Arabic in the 12th century aimed at the recovery of the Greek-Ancient learning. This is a gross fallacy. The medieval Western translators, who were behind the rise and renaissance of Western Christendom, and the authors of the largest translation effort in history, from Arabic into Latin, in the 12th-early 13th century, were not interested in the Greek-Ancient material but in Muslim learning. Whether Adelard of Bath, who talked of his Arab masters,[3466] or Daniel of Morley who compared Paris' scholars to asses, and who rushed back to Toledo in Spain to dwell amongst 'Arab' books,'[3467] or Gerard of Cremona who pitied the Latin for the poverty of their learning compared to the Muslims,[3468] or Robert of Ketton, who speaks of ' the depths of the treasures of the Arabs,'[3469] all sought Islamic learning. They thought very little of Ancient learning. Raymond of Marseilles, for instance, in 1140, says 'that students of astronomy were compelled to have recourse to worthless writings going under the name of Ptolemy and therefore blindly followed; that the heavens were never examined, and that any phenomena not agreeing with such books were simply denied.'[3470] The same attitude was held in regard to medicine. Stephen of Antioch who translated the *Liber Regalis* of Al-Madjusi, even learned Arabic in order to advance from "the naked beginnings of philosophy," and he proposed, if the favour of God should permit, to go on from his study of the things of the body to "things far higher, extending to the excellence of the soul," more specifically, "more famous things which the Arabic language contains, the hidden secrets of philosophy."[3471]

[3464] C.J. M. Whitty: the Islamic Impact on medicine; op cit; p. 52.
[3465] N. Culpeper: *A Physicall Directory, or, a Translation of the London Dispensatory Made by the College of Physicians in London* (London; 1649).
[3466] D. Metlitzki: *The Matter of Araby in Medieval England* (Yale University Press, 1977), p.13.
[3467] *Daniels Von Morley Liber de naturis inferiorum et superiorum*; ed Sudhoff; p. 32; in D. Metlitzki: *The Matter*; op cit; p. 60.
[3468] M.I. Shaikh: extract from 'Penzance Manuscript; *'The International Conference of Islamic Physicians' Contribution to the History of Medicine* (International Institute of Islamic Medicine.) June 26-30, 1998; The International Convention Centre Birmingham, U.K.
[3469] H. of Carinthia: *De essentiis;* ed and tr C. Burnett (Leiden; 1982), p. 70.
[3470] J.L. E. Dreyer: Mediaeval astronomy; in *Toward Modern Science*; R.M. Palter ed (The Noonday Press; New York; 1961), Vol 1, pp 235-256; p.243.
[3471] N. Daniel: *The Arabs and Medieval Europe*; op cit; p. 264.

Perhaps he was thinking of works by Ibn Sina, to which his medical interests might have led him.[3472] For Stephen and for most of the translators from Arabic the idea of Greek sources at this date was secondary, and the impact of Byzantium was much less than that of the Arabs, especially in Spain.[3473]

Just as the intentions of the medieval scholars have been misrepresented by modern historians, medieval and later Islamic breakthroughs have also been misrepresented by these same historians through wrong attributions. Vaccination, for instance, wrongly attributed to Jenner (1749-1823). The method of vaccination was known to the Ottoman Turks long before Jenner, under the name of *Ashi* (engrafting), which they had inherited from old Turkic tribes; the nomads used to inoculating their children with cowpox taken from the breast of cattle. This kind of vaccination and other forms of variolation were introduced into England by Lady Montagu, wife of the English ambassador at Istanbul between 1716-1718. She had come across the Turkish practice and became greatly interested in it, even consenting to have her son inoculated by the Embassy surgeon Charles Maitland.[3474] The story went, as Armesto explains, that whilst the father of the boy took no notice, his mother professed her ease; yet the six year old was covered in pustules, with swollen arms, dry mouth, and an urgent fever.[3475] It was the spring of 1718 in Istanbul, where his parents had come on a mission from London, the boy's mother was Lady Mary Wortley Montague, and she had volunteered him as a guinea pig in an experimental inoculation against smallpox. The embassy physician described the technique: 'She put the child to so much torture with her blunt and rusty needle that I pitied his cries.'[3476] Yet the experiment was merciful success, and when London was threatened with epidemic in 1721, Lady Mary repeated it on her daughter, converting society to the practice in consequence.[3477] Previous efforts by savants to introduce vaccination had been 'regarded as virtuoso amusements;' now, however, 'Lady Mary fulfilled an ambition she had conceived as a patriotic duty, on seeing an inoculation performed at Adrianople, 'to bring this useful invention to England.'[3478] A scientific work was submitted to the Royal

[3472] Ibid.
[3473] Ibid.
[3474] Chambers Compact: *The Great Scientific Discoveries* (1991), pp 209-10.
[3475] F. Fernandez-Armesto: *Millennium* (A Touchstone Book, Simon and Shuster; New York; 1995), pp. 275-6.
[3476] Ibid.
[3477] Ibid.
[3478] Ibid.

Society in 1724 by the Montagus' family physician in Istanbul, and inoculation was adopted both in England and in France nearly half a century before Jenner.[3479] It may seem ironic, Armesto observes, that one of the great benefits spread by modern and Western science should have originated as a Turkish folk remedy.[3480]

A similar problem of misattribution relates to the matter of pulmonary circulation. The Syrian medical scholar Ibn Al-Nafis (1210-1288) described it in his *Sharh al-Qanun,* a Ms. which can be found in a number of examples in Berlin, Paris, Bologna, Beirut, Damascus, the Escurial (Spain), Istanbul, and Oxford.[3481] His commentary was consulted by his contemporary Ibn al-Quff, who explained the basic principles of the modern theory of the lesser or pulmonary circulation.[3482] How Ibn-al-Nafis came to discover the pulmonary circulation, according to Meyerhof, was a happy hypothesis. Whipple disagrees with this, pointing to the definite statements that Ibn al-Nafis makes on the actual anatomy of the heart and the interventricular septum.[3483] Three centuries after the discovery of the pulmonary circulation by Ibn Al-Nafis, others: Michael Servetus, Realdus Columbus, Carlo Ruini, Andrea Cesalpino, and Francois Rabelais claimed the same results.[3484] Ibn al-Nafis' discovery is also 350 years earlier than Harvey's who was credited with it. In 1957, Latham noted how Ibn Al-Nafis understood the fallacy of Galen's theory of invisible channels between the ventricles, and explained that blood was purified in the lungs where it was refined on contact with the air inhaled from the outer atmosphere.[3485] The role of Ibn al-Nafis in the said discovery can be found well explained in two doctoral theses, the first, and pioneering one, by the Egyptian, Mohy ad-Din at-Tatawi, held at the German University of Friburg in 1924,[3486] the second, held at Paris in 1951, incorporating some new detail, was published by A.K. Chehade.[3487] Despite such well founded works, mainstream Western history still

[3479] Chambers Compact: *The Great Scientific Discoveries*; op cit; pp 209-10.
[3480] F. Fernandez-Armesto: *Millennium;* op cit; pp. 275-6.
[3481] A. Whipple : *The Role; op cit;* p. 48.
[3482] Ibid.
[3483] Ibid.
[3484] M. Meyerhof: Ibn Nafis et sa theorie sur la petite circulation; *ISIS* 23. pp. 100-20.
[3485] The Sunday Times 9 June 1957. See also *Journal of History of Medicine*, Vol 12 (1957), pp 248-283.
[3486] M. Meyerhof: La Decouverte de la circulation pulmonaire par Ibn an-Nafis; in *Bulletin de l'Institut d'Egypte*; XVI pp. 33-46; Meyerhof, who en passant, does not fail to acknowledge the pioneering achievement of Tatawi (at p.34).
[3487] A.K. Chehade: *Ibn an-Nafis et la decouverte de la circulation pulmonaire* (Paris and Damascus; 1955).

refuses to acknowledge Ibn al-Nafis' role. Wilson, for instance, asserts that the Christian doctors made the discovery independently.[3488] Which is odd, considering that all of them made the same discovery in the space of a few years, soon after the translation of Ibn al-Nafis treatise by Alpago (in the second decade of the 16th century),[3489] soon after the arrival of Ibn al-Nafis' work in Padua, and all such writings being often nearly word for word repetition of Ibn al-Nafis.[3490] Mowry, for his part, held:

> 'This was Galen's theory. It persisted unchanged and unchallenged down to the Renaissance (by Vesalius-Columbus).'[3491]

Which is false, for, as shown above, and as amply detailed in his work referred to already, Ibn al-Nafis did challenge Galen profusely, and built his theory in complete opposition to Galen's.

It is worth ending this heading with the sort of confused and confusing, contradictory statements in relation to the role and impact of Islamic science, which are made by most historians. Here the culprit is Campbell. First, he says:

> 'His (Al-Zahrawi's) surgical teaching, which was a distinct advance on the surgery of the travelling mountebanks, retarded the progress of surgery in the Latin West, as it produced a tendency to rely on the anatomical doctrines of Galen rather than on actual dissections. The blame for this cannot be laid entirely on Albucasis as the mental attitude of the scholastics of Latin Europe was one that leaned on the wisdom of the ancients, and thus it was that Albucasis' opinion of Galen's anatomy was readily assimilated by the West.'[3492]

Campbell, then, in the following page, holds:

> 'The chief influence of Albucasis on the medical system of Europe was that his lucidity and method of presentation awakened a prepossession in favour of Arabic literature among the scholars of the West: the methods of Albucasis eclipsed those of Galen and maintained a dominant position in medical Europe for five

[3488] L. G. Wilson: The problem of the discovery of the pulmonary circulation; in *Journal of History of Medicine;* vol 17; (1962) pp 229-44.
[3489] F. Micheau: La Transmisison a l'Occident Chretien: Les traductions medievales de l'Arabe au Latin; in *Etats; Societes et Cultures; op cit*; pp. 399-420; pp. 417-8.
[3490] M. Meyerhof: Ibn Nafis et sa theorie; op cit.
[3491] B. Mowry: From Galen's (b.130-d.200) Theory to William Harvey's theory: A case study in the Rationality of scientific theory; *Studies in History and Philosophy of Science*; Vol 16; pp 49-82; at p. 51.
[3492] D. Campbell: *Arabian;* op cit; p. 87.

> hundred years, i.e long after it had passed its usefulness. He, however, helped to raise the status of surgery in Christian Europe; in his book on fractures and luxations, he states that 'this part of surgery has passed into the hands of vulgar and uncultivated minds, for which reason it has fallen into contempt.' The surgery of Albucasis became firmly grafted on Europe after the time of Guy de Chauliac (d.1368).'[3493]

5. Pharmacy and Pharmacology:

From very early to comparatively late periods of the history of drug-lore, Isaac explains, the preparation, action and uses of drugs were closely associated, often indeed identified, with witchcraft and divination.[3494] It is Islam, he pursues, which purged pharmacology of such practices; Islamic pharmaceutical tradition, on the whole, being rational, clean and practical.[3495] Isaac notes the saying of the Prophet: '*li kulli da'in dawa*' (for every disease there is a remedy), is a religious explanation: it is left to the physician, through his knowledge and skill, to trace the right drug that God had created.[3496] Hamarneh also says that interest in natural products and ecology was 'a corollary to the Muslim belief that God provides for the creatures He has created.'[3497] Hamarneh continues:

> 'In Nature God provides the right medications for man's ailments, when and where they are most needed. Natural medications are tokens of God's generous attitude toward human beings, His ways of enriching their lives and providing for their needs, a belief which prompted Muslim naturalists, herbalists, pharmacists, and physicians to seek remedies in nature.'[3498]

Faith aside, the vast, borderless world of Islam stimulated travel over very long distances to procure certain plants or roots not to be found nearer home, or to be obtained in more perfect condition than from ordinary

[3493] Ibid; p. 88.
[3494] H.D. Isaac: Arabic Medical Literature: in *Religion*; M.J.L. Young et al ed; op cit; pp 342-64; p. 361.
[3495] Ibid.
[3496] Ibid.
[3497] S.K. Hamarneh: The Life Sciences: in *The Genius*; J.R. Hayes ed; op cit; p. 156.
[3498] Ibid.

dealers.[3499] Ibn al-Baytar (1197-1248), thanks to his travels, managed to accumulate a vast knowledge in the field. His extensive travels began in 1216-7 in search and collection of plants. In Bejaia, in Algeria, he found and describes at length the Athrilal (Latin: *ptychotisverticillata)* which a local tribe traded as a specific remedy against leprosy.[3500] Ibn al-Baytar made the same discoveries and collections in Constantine, Tunis, Tripoli, and other places he visited.[3501] Wherever he went, Ibn al-Baytar entered into contact with local scholars to seek further information on local plants. His *Kitab-ul-Jami fil Adwiyah al-Mufradah* (Dictionary of Simple Remedies and Food) is the most important treatise of all, describing 3000 simples, all listed in alphabetical order, and dealing with over 150 authors.[3502] It includes personal observations by himself.[3503] Ibn al-Baytar's contemporary, Rashid Eddin al-Suri (d. 1241), even used to take a painter with him in his outings in search for medicinal plants, recording each of them by having them painted at different stages of their growth for inclusion in his book.[3504]

Muslim pharmacists discovered new and simple drugs in their crude forms, and gave detailed descriptions of their geographical source, physical properties, methods of application, the pharmaceutical forms of the remedies used, and the techniques employed in their manufacture.[3505] Some writers emphasised the botanical description of the drugs; others their potency, their mode of operation, their composition, and the forms which the medicaments took (that is to say, preparations like pastes, solutions, tinctures, etc.), and also synonyms for drugs, and other topics.[3506] Ibn Sahl (d. 869) was the first physician to initiate pharmacopoeia, describing a large variety of drugs and remedies for ailments.[3507] Ibn Sina, described no less than 700 preparations, their properties, mode of action and their indications in his *Canon*.[3508] Such information can also be found in works

[3499] H.D. Isaac: Arabic Medical Literature; op cit; p. 362.
[3500] L. Leclerc: *Histoire*; op cit; vol 2; p. 226.
[3501] Ibid.
[3502] J. Vernet and J. Samso: Development of Arabic Science in Andalusia, in *Encyclopaedia*. (Rashed ed); op cit; pp 243-76; at pp. 271-2.
[3503] Ibid.
[3504] I. and L Al-Faruqi: *The Cultural Atlas,* op cit, p 328.
[3505] S.K. Hamarneh: The Life Sciences; op cit; p. 156.
[3506] A Dietrich: Islamic Sciences and the Medieval West, Pharmacology in *Islam and the Medieval West*; I.K. Semaan; ed (State University of New York, Albany; 1980), pp 50-63: p.50.
[3507] E.S. Kennedy: Al-Biruni; in *Dictionary of Scientific Biography*; op cit; vol 2; pp. 147-58; at p. 155.
[3508] Volume ii includes the names of simple drugs arranged in alphabetical order.

(generally bearing the title *Jami al-adwiya al-mufrada* (Collection of Simples) such as those of Ibn Samjun (d. 1002), al-Ghafiqui (d.1165), Ibn Rumia (1142-1218) and others' treatises on simples; Ibn Rumia, for instance, introduces new methods of investigating properties and uses of drugs.[3509] Al-Biruni (d 1051), in his *Kitab al-Saydalah* (Pharmacology), lists and describes the properties of drugs, giving the technical terminology for categories of drugs; the general theory of medicaments, therapeutic properties of substances, etc.[3510] In the introduction to his Book of Drugs, Al-Biruni explains:

> 'Everything that is absorbed, voluntarily or unconsciously, can be divided first of all into foods and poisons. Remedies are placed half way between these two. Foods receive their qualities from active and passive forces, and primarily from their four degrees, so that the body, in equilibrium, has the power to transform nutriment into its own substance by complete digestion and by assimilation, thus replacing what part of the diet has been lost by disassimilation. That is the reason why the body must act on food before it can derive any benefit from it. As for poisons, they receive their qualities from the same forces but at their highest degree, which is the fourth, in such a way that they overpower the body and subject it to morbid and fatal transformations.... As for drugs, they are placed between the two, because they are corruptive with respect to food and curative with respect to poisons. Their curative action can be wrought only by skilful and scrupulous physicians. In addition, there are the medicinal foods, half way between drugs and food, and the toxic medicaments, half way between drugs and poisons.'[3511]

Minerals had great significance as remedies among the Muslims. Antimony is said to have been recommended for ophtalmia by the Prophet himself, and turns up regularly in Arabic literature on eye disease.[3512] In dermatology, we find early mention of ointments containing sulphur and mercury.[3513] By the time of Al-Zahrawi the external use of these substances was obviously a major concern of the Muslim physicians.[3514]

[3509] Max Meyerhof. (1935 b) Esquisse d'Histoire de la pharmacologie et de la botanique chez les Muslmans d'Espagne', *Al-Andalus* 3; pp. 1-41.
[3510] E.S. Kennedy: Al-Biruni; op cit; vol 2; pp. 147-58; at p. 155.
[3511] In R. Arnaldez-L.Massignon: Arabic Science; op cit; p. 419.
[3512] Browne, 1921; in R.P. Multhauf: *The Origins of Chemistry*; op cit; p.217.
[3513] Friedman (1938) mentions both in connection with al-Tabbari in R.P. Multhauf: *The Origins of Chemistry*; op cit; p.217..
[3514] R.P. Multhauf: *The Origins of Chemistry;* op cit; p.217.

n the oldest Muslim lapidary extant, by Utarid Ibn Mohammed al-Hasib (9th century) *Kitab manafi' al-ahjar or Kitab al-jawahir wa'l Ahjar* (The Book of Virtues of Minerals or the Book of Precious Stones and Minerals), the properties of precious stones are described.[3515] Ibn Sina in his *Kitab al-Shifa* (the Book of Healing), devotes a section to mineralogy, which includes stones and various chemicals.[3516] On vitriols, he says:

> 'The vitriols are composed of a salty principle, a sulfurous principle and stone, and contain the virtue of some of the fusible bodies (metals). Those of them which resemble *qalqand* and *qalqatar* are formed from crude vitriols by partial solution, the salty constituent alone dissolving, together with whatever sulferity there may be. Coagulation follows, after a virtue has been acquired from a metallic ore. Those that acquire the virtue of iron become red of yellow, e.g. *qalqatar*, while those which acquire the virtue of copper become green. It is for these reasons that they are so easily prepared by means of this art.'[3517]

As excellent organisers of knowledge, Levey points out, Muslim writers directed their pharmacological texts along paths which either seemed more promising or more useful to the apothecary and medical practitioner.[3518] Ibn Massawayh (Junior) (d.1015), for instance, was to became famous in the Latin West for his pharmacopoeia, which was divided into several sections, dealing with correctives to medicines, simple purgative remedies, composite medicines and lastly medicines as intended for each of the specific individual diseases.[3519] The Muslims also appended to each name its synonyms in other languages in order to arrive at as unambiguous a definition of the drugs as possible.[3520] Ibn al-Baytar's greater merit, for instance, was in the systematisation of the discoveries made by Muslims in the Middle Ages, and he was also concerned with finding the technical equivalents between Arab, Berber, Greek, Latin, Persian and Romance languages.[3521] Considering such materials, Dietrich concludes, shows that the Muslim pharmacists did not, after all, compile

[3515] M. Levey: *Early Arabic Pharmacology;* op cit; p. 164.
[3516] R.J. Holmyard and D.C. Mandeville: *Avicennae de Congelatione et Conglutinatione lapidum;* being sections of the *Kitab al-Shifa*; pp. 39 ff.
[3517] M. Levey: *Early Arabic Pharmacology;* op cit; p. 165.
[3518] M. Levey: Influence of Arabic Pharmacology on Medieval Europe; in *Convegno Internationale:*, op cit; pp. 431-44. p. 438.
[3519] G. Wiet et al: *History;* op cit; p. 663.
[3520] A Dietrich: Islamic science; op cit; p.52.
[3521] E. Calvo: Ibn al-Baytar, in *Encyclopaedia of the History of Science* (Selin ed), op cit; p. 404.

their material in as cavalier a manner as has sometimes been said of them.[3522]

Also, contrary to what is generally assumed, the Muslims largely surpassed their predecessors in the field. First of all in their numbers. Meyerhof was able to trace about a hundred and ten writers who worked in this field.[3523] The Muslims also added several hundred drugs to the stock of medicaments known to the Greeks.[3524] Ibn Juljul (d.944), for instance, introduced a whole range of new medical plants into therapeutics.[3525] Ibn Juljul was conscious of the fact that since the days of Dioscorides medicine and botany had developed new items used for medication which had come from the East, or were found in Andalus. He produced a Supplement "on those drugs which Dioscorides did not mention", containing around sixty items.[3526] Leclerc has calculated that the thirteenth century botanist Ibn al-Baytar listed some 200 plants which were unknown to Dioscorides;[3527] others cite an even larger figure approaching a thousand.[3528] All in all, and in quantity, the number of simples and compound remedies rose under the Muslims to about 4,000 in the later works, which is a considerable number compared to the mere hundreds in the Greek works.[3529]

More importantly, as with every science, the Muslims were not merely followers of the Greek as scholarship tends to accuse them of being. Ibn Wafid (Abenguefith to his Latin translators), the vizier and director of the botanical garden of the princely house of Toledo, and the author of the earliest pharmacopoeia treatise in the Muslim West, for instance, bases himself on the ancients, but takes into account the remedies he has himself seen used to good effect in Spain.[3530] The same with Ibn Juljul, who used and respected the 'Ancients' but did not simply transmit the Greek learning; he made valuable contributions to the practical knowledge and use of medicinal plants, and was held in high respect by contemporary and later scholars and physicians.[3531]

[3522] A Dietrich: Islamic science; op cit; p.50.
[3523] M. Meyerhof in A Dietrich: Islamic science; op cit; p.52.
[3524] Ibid.
[3525] L. Leclerc: Histoire de la Medecine; in A. Dietrich: Islamic sciences; op cit; p.55.
[3526] P. Johnstone: Ibn Juljul; in *Islamic Culture* (1999), pp. 37-43; at. p.39.
[3527] Ibn al-Baytar *Kitab-ul-Jami fil Adwiyah al-Mufradah*; in L. Leclerc: *Histoire de la Medicine Arabe*; op cit; vol 1; p. xi.
[3528] See J. Vernet and J. Samso: Development, op cit, pp 271-2, and N. Leclerc: *Histoire*; op cit; pp. 226 ff.
[3529] M. Levey: *Early Arabic;* op cit; p. 173.
[3530] G. Wiet et al: *History;* op cit; p.659.
[3531] P Johnstone: Ibn Juljul; op cit; p. 42.

As pharmacology made progress, Levey points out, other sciences advanced to keep up with it.[3532] In the early Muslim period, as he explains, pharmacology was the mother of chemistry. In this way, the Muslims provided ample information regarding chemicals and their physical and chemical properties and reactions.[3533] This process of elaboration was carried on by the scholars of the Christian West until the breakthrough in chemistry a few hundred years ago.[3534] Developments in Muslim chemistry including filtration, distillation and crystallisation also had a decisive impact on the rise and growth of modern pharmacy.[3535]

Cosmetology is one area, little known, which benefited greatly from progress in pharmacology. Al-Zahrawi, in the 19th volume of his *Al-Tasrif,* considers cosmetics a definite branch of medication (*Adwiyat al-Zeenah*). He looks at the care and beautification of hair (mentioning hair dyes), skin, teeth and other parts of the body. He has his solutions for mouth hygiene, and bad breath for which he suggests cinnamon, nutmeg, cardamom and chewing on coriander leaves. He also includes methods for strengthening gums and bleaching the teeth. He deals with body odours and fighting them with perfumes, scented aromatics and incense, and included under-arm deodorants, hair removing sticks and hand lotions. Al-Zahrawi mentions the benefits of suntan lotions, describing their ingredients in detail, and describes nasal sprays and hand creams. Al-Zahrawi also suggests keeping clothes in an incense filled room to make them carry a pleasant fragrance for the wearer.[3536]

Sahlan ibn Kaysan's (d.990) *Mukhtassar fi al-Adwiya al-murakabba al-musta'mala fi akhbar al-amrad* (Compounded Drugs Used in Most Ailments) has chapters which deal with myrobalan confections, electuaries, pills, aperients, pastilles, powders, syrups, lohochs, and robs, gargles, collyria, suppositories, pessaries, poultices, oils and lotions, buccal medicines and dentifrices, and pomades.[3537] Many variations of this type of text were known.[3538]

[3532] M. Levey: *Early Arabic*, op cit, p. 53.
[3533] Ibid, p. 173.
[3534] Ibid.
[3535] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 49.
[3536] Mainly derived from the following sources:
-S.K Hamarneh and G. Sonnedecker: *A Pharmaceutical View of Albucassis Al-Zahrawi in Moorish Spain* (Leiden, coll. Janus, suppl. 5, 1963).
-M. Levey: *Early Arabic*, op cit.
[3537] M. Levey: Influence of Arabic Pharmacology on Medieval Europe; op cit; p. 438.
[3538] P. Sbath and C.D. Avierinos: *Deux Traites Medicaux* (Cairo; 1953).

Likewise, those whose work led to perfumery and distillatory operations learned to provide more suitable raw material for the apothecary and physician.[3539]

With pharmacology and its related sciences there naturally developed experimentation. Muslim practioners experimented with drugs in order to learn more about their effect on humans, often using a single drug in the treatment of each ailment in order to determine its precise effect.[3540] Experiments were reported in notebook collections of case histories, sometimes known as *al-Mujarrabat;* whilst other manuals included charts, diagrams, and tables that dealt with drugs and diseases listing their causes and symptoms, their seasonal prevalence, and the dosages of drugs administered.[3541] Others included mathematical calculations concerning the potency of drugs and the recommended dosages according to age, sex, and the severity of the sickness.[3542] Several physicians prescribed and compounded their own medications, giving them specific names, from the recipes they formulated themselves, often indicating the pharmacological action that would result, a practice usually followed with modern patented medicines.[3543] Al-Zahrawi's (940-1013) *al-Tasrif,* known in Latin as *liber servitoris de praeparatione medicinarum simplicium*, for instance, describes chemical preparations, tablet making, filtering extracts, and related pharmaceutical techniques.[3544]

The Islamic impact on the Christian West in the subject was quite enormous, and this is highlighted by the briefest of outlines. In terms of collections of recipes for medicines, the huge corpus of Islamic pharmacology and plant learning influenced these very heavily- indeed some of these works were almost direct cribs from the original works of writers like Ibn Massawayh.[3545] The *Antidotarium* of Ibn Massawayh (d. 857) (Mesue) was plagiarised and copied into books of medical recipes for six hundred years.[3546] Some of these Western works relying on Islamic pharmacology are almost exclusively medical, for example, Andrew Borde's *The Breviarie of Health.*[3547] Some are a mixture of

[3539] M. Levey: *Early Arabic,* op cit, p. 173.
[3540] S.K. Hamarneh: The Life Sciences; op cit; p. 156.
[3541] Ibid.
[3542] Ibid; p. 156-7.
[3543] Ibid; p. 157.
[3544] See G. Sarton: *Introduction*; vol 1; op cit. p. 534.
[3545] J.C.M. Whitty: The Impact of Islamic Medicine; op cit; p. 52.
[3546] Ibid; p. 49.
[3547] A. Borde: *The breviarie of health; wherin doth follow remedies, for all manner of sickneses and diseases, the which may be in man or woman* (London, 1552). Other

medicines and handy hints on domestic matters like how to scent gloves, or make marmalade, such as Partridges bestseller *The Huswives Closet* and its sister volume *The Widowes Tresure*.[3548] In a separate category were the herbals, books which combine some botany with medicine.[3549] Herbals were possibly the most popular and long lived of them all-the most famous of them, *Culpeper's Herbal*, is still in print and can be obtained in any British bookseller to this day, containing recipes which the Islamic writers of one thousand years ago would recognise as their own.[3550] The impression that Islamic drugs dominated medical practice is supported by examining customs records or apothecaries books.[3551] In the late 17th century, an edition was made of the London Dispensatory. Its list of botanicals, simples, minerals, compound drugs for external and internal uses, oils, pills, cataplasms, etc, also highlights this Muslim influence.[3552] Subsequently, parts of the Latin version of Ibn al-Baytar's *Simplicia* were printed in 1758; whilst Ibn Sarabi and Ibn Massawaih were studied and summarized for the use of European pharmacopoeias until about 1830.[3553] Latin and German translations, and limited Spanish version of Ibn Al-Baytar's pharmaceutical compendium, *Kitab-ul-Jami fil Adwiyah al-Mufradah* (Dictionary of Simple Remedies and Food), were made before a complete translation appeared in 1842.[3554]

There is today a fairly adequate number of secondary sources dealing with the history of Muslim pharmacy. Meyerhof has written many works of great interest, which constitute major sources of reference.[3555] Ulmann is another

examples are Anon, *Here begynneth a newe boke of medecynes intyttuled or callyd the Treasure of Pore Men;* London, 1526; or Anon: *The antidotarius, in which thou mayst lern how thou shalt make playsters, salves, ointments (*London, 1535). All ran to several editions.

[3548] J. Partridge: The tresurie of comodious conciets, and hidden secrets, and may be called, the huswives closet, of healthful provision; (London, 1573); J. Partridge: *The widowes tresure, plentifuly furnished with secrets in physic; (*London, 1586). Both were still popular in the mid-seventeenth century.

[3549] Herbals overlapped very considerably, and were usually variations on a theme. An example is Anon: *Here begynneth a newe mater: the which is called an herbal* (London, 1526).

[3550] N. Culpeper: *Culpeper's Complete Herbal;* Wordsworth, (London 1995).

[3551] For example, R.S. Roberts: The Early History of the Import of drugs into Britain; in F. Poynter ed: *The Evolution of Pharmacy in Britain* (London, 1965); M. Rowe, G.E. Trease, Thomas Baskerville: Elizabethan Apothecary of Exeter, *Trans British Soc. Hist. Pharm* (1970): 1; pp. 3-28.

[3552] M. Levey: *Early Arabic*, op cit, op cit; p. 177.

[3553] E. J. Jurji: The Course of Arabic. p. 249.

[3554] For details, see N.L. Leclerc: *Histoire de la Medecine;* vol 2; pp. 233-4.

[3555] M. Meyerhof: 'Uber die Pharmacologie und Botanik des Ahmad al-Ghafiqi', *Archiv fur Geschichte der Mathematik und Naturwissenschaft* 13 (1930), pp. 65-74.

good source albeit he remains available in German mainly;[3556] which is also the case for Meyer.[3557] Levey's work in English on early Muslim pharmacy is excellent.[3558]

Original Islamic manuscripts constitute the best source to know more on the subject. However, these manuscripts remain to a great extent untouched. Dietrich observes that approximately a quarter of the extensive Muslim production is probably extant, and very little of it printed, most of it in manuscript form in libraries, especially those of the East.[3559] It is all the more crucial to access such sources, because, as Levey insists, the impact of Muslim pharmacology lasted into the 19th century in the West, and as a result of its accumulation of data from over thousands of years' experience, this may continue to lead to valuable facts today.[3560] Medicinal properties of botanical sources known by Muslim physicians and apothecaries deserve greater attention than has been possible hitherto.[3561] Some important medicinal plants have been explored as to their physiologically active principles and chemical activity with success, but more of this remains to be done, for some clues leading to potentially valuable drugs may still be found in the medical Islamic texts.[3562] Levey lists some of the works that deserve translation into English:

-Al-Ansari (d. 1292): *Al-Simat fi asma' al-Nabat* (Special Considerations on Names of Plants); (MS: Bibliotheque Nationale, Paris, Arabe 3004).

-Ishaq B. Sulaiman: (903? 953?): *Kitab al-Aghdhiya wa'l adwiya* (Book on Nutritives and Drugs); (MS. Munchen 809).

-Al-Tamimi (late 10th): *Kitab al-Murshid ila jawahir al-Aghdhiya waquiwa'l-mufradat min al-Adwiya* (Guide Book on Nutritives and the Properties of Simple Drugs); (MS Bibliotheque National Arabe 2870).

-Ibn Jazla (d. 1100): *Minhaj al-bayan fima vasta' Miluhu'l-insan* (Manual of Explanation in What One Employs); (MS Leiden 1355; MS Shebit Ali 2107).

-Al-Kuhin b.Attar: *Minhaj al-Dukkan* (Manual of the Pharmacy); (MS Leiden 1360; MS Munchen 833.)[3563]

-M.Meyerhof: Esquisse d'histoire de la pharmacologie et de la botanique chez les Musulmans d'Espagne', *al-Andalus* 3, 1935: pp. 1-41.

[3556] M. Ullmann: *Medizin in Islam* (Leiden/Cologne, 1970).

" " ; *Die Natur und Geheimwissenschaften im Islam*, Leiden, coll. handbuch der Orientalistik, I. VI, 2, (1972).

[3557] E. H. F. Meyer: *Geschichte der Botanik,* I-IV (Konigsberg,1854-7).

[3558] M. Levey: *Early Arabic Pharmacology* (E. J. Brill; Leiden, 1973).

[3559] A Dietrich: Islamic science; op cit; p.52.

[3560] M. Levey: Influence of Arabic Pharmacology on Medieval Europe; op cit; p. 431.

[3561] Ibid.

[3562] Ibid.

[3563] M. Levey: *Early Arabic*, op cit, pp 58-9.

6. Surgery:

According to Elgood, the position of the surgeon in the time of the caliphs was one of honour, and he was not looked down upon by the physicians as was the case in Europe during the Middle Ages.[3564] Reflecting the high status of the science, nearly every single Muslim medical writer had a chapter on surgery, covering one aspect of it or another.[3565] The primary role of surgery in terminating many cases of ill health was well understood. Al-Madjusi, in his *Liber Regius,* considered treatment with surgery as of equal importance as treatment with drugs.[3566] In the surgical section of his work, he described many surgical conditions and gives sound advice on treatment.[3567] For instance, he describes laryngotomy, advising the operator, after cutting the skin, to draw the tissues apart with hooks, and then, exposing the trachea, to open it between the cartilages.[3568] When an artery is wounded, it should be dissected out and silk ligatures applied on either side; and after these have been tied, the artery should be severed between.[3569] He recommends excision in cancers of the breast and extremities.[3570] Abu Mansur Muwafaq (fl. Late 10th century) was the first to describe the use of plaster of Paris in the treatment of broken bones.[3571] Through some mischance of history, this discovery never became widely known, and it was not until 1852 that the treatment was reintroduced into medical practice.[3572] Ibn Sina's description of the treatment of malignant disease might have been penned today; the only hope of cure he says is to take the disease in the early stages. [3573] The excision must be wide and bold; all veins running to the tumour must be included in the amputation, and even this is not sufficient; the affected area should be cauterized. Even then ...cure is not certain.[3574] The lesser known Muslim surgeon, Ibn al-Ayn Zarbi (d. 1153), who

[3564] C. Elgood: *A Medical History of Persia (*Cambridge University Press, 1951), p.279.
[3565] I B. Syyed: Medicine and medical Education in Islamic History, in *Islamic Perspective;* op cit; pp 45-56; at p 52.
[3566] In A. Whipple: *The Role*; op cit; p.63.
[3567] R.H. Major: *A History of Medicine*; op cit; p. 241.
[3568] Ibid.
[3569] Ibid.
[3570] Ibid.
[3571] E.J. Holmyard: Medieval Arabic Pharmacology; in *Proceedings of the Royal Society of Medicine*; Vol 29 (1935-6), pp. 99-108; at p. 105.
[3572] Ibid.
[3573] A. Whipple: *The Role*; op cit; p. 63.
[3574] Ibid; pp.63-4.

originally comes from the Seljuk Heartland, authored many works on the healing art, most of which are, unfortunately lost.[3575] He describes many injuries such as stab wounds, injuries to the head, bones and skin and how to care for them.[3576] Concisely and accurately, he describes methods and techniques for bone setting, suturing and bandaging, and he also makes useful observations of scrofula, especially the fugitive and ganglionic types of this glandular, lymphatic disease.[3577]
The main Muslim surgeon, however, was Al-Zahrawi, whose work is examined below at some length.

a. The Surgery of al-Zahrawi:

The principal Muslim surgeon was Al-Zahrawi's, whose *al-Tasrif,* known in Latin as *liber servitoris,* is a rich treatise, which describes many operations in great detail as the following extracts will show.[3578] For his purposes, Al-Zahrawi constructed a great number of instruments and devised a number of surgical procedures. He explains with the aid of drawings the use of such instruments and surgical operations in great detail.[3579] In fact, the surgical portion, produced separately, was the first illustrated work on surgery.[3580] Al-Zahrawi's descriptions of operations are clear and particularly valuable because they portray the figures of surgical instruments used in the Middle Ages, for there are few illustrations dating from the Muslim period.[3581] Most of the figures of medieval times were derived from those of Al-Zahrawi (and incidentally show no knowledge of perspective).[3582] Indeed, Al-Zahrawi's surgical tract was translated into Latin by Gerard of Cremona in the 12th century in Toledo,[3583] and the Latin translation of *al-Tasrif* was printed in Venice in

[3575] S.K. Hamarneh: Ibn al-Ayn Zarbi, and his definitions of dieases and their diagnoses; in *Proceedings of the International Symposium for the History of Arabic Science* (Aleppo; 1976), pp.305-323; at pp. 305; 308.
[3576] Ibid; pp. 320-1.
[3577] Ibid, pp. 321.
[3578] M.S. Spink and G.L. Lewis: *Abulcasis on Surgery and Instruments* (The Wellcome Institute, London, 1973).
[3579] Ibid.
[3580] D. Guthrie: *A History of Medicine*; op cit; p. 93.
[3581] Ibid; p. 88.
[3582] Ibid; p. 88.
[3583] An illustrated Ms. of Al-Zahrawi's *Chirurgia* translated by Gerard of Cremona is Paris. 10,236. Another very early manuscript is Bamberg, Roman 53, 15; yet another of the 13th century is Bibliothque Francaise, 13, 15. There is a manuscript (containing

1497 (and reprinted in 1500); and also in Strasbourg in 1532 and Basle 1541.[3584] The Basle edition is illustrated with woodcuts which are dissimilar to those in Channing's translation, which also contains commentaries by Roland, Roger, Constantine, and Gasius.[3585] The Basle edition is also of interest, as it formed the basis of the work of John Channing who published his *Albucasis de Chirugia* in 1778.[3586] The reference to gynaecology in it was published by Gaspar Wolph in his *Collectio Gynaeciorum*.[3587] This treatise, *Al-Tasrif*, because it is so rich, and because it is not often used by historians on the subject, deserves a lengthy summary here.[3588]

It is appropriate to begin with a point that Al-Zahrawi raises towards the end of his work (P. 676), saying:

> 'Whatever skill I have, I have derived for myself by my long reading of the books of the Ancients and my thirst to understand them until I extracted the knowledge of it from them. Then through the whole of my life, I have adhered to experience and practice. So now I have described for you in this book all that my knowledge has encompassed on the subject, and that my experience has encountered; I have made it accessible for you and rescued it from the abyss of prolixity; I have reduced it to a brief outline; and have explained it most clearly. I have made for you many drawings of the instruments that are used in it, which is an adjunct to explanation, as I did in the previous two books. And there is no power save in God the High, the Great.'

An absolutely faultless paragraph, catching the very essence of Islamic science in all its dimensions: the recognition of the works of the predecessors; the need for experiment; the legacy of knowledge to successors; the determined search for clarity; and the absolute and foremost faith in God, and His guidance.

The first practical matter to preoccupy Al-Zahrawi (p. 4 ff.) relates to the precautions a surgeon has to take in performing any surgical operation. He says he witnessed a surgeon incising a scrofulous tumour in a woman's neck, cutting arteries in the neck causing her to bleed to death. Another

extracts) at Montpellier (14th century), and another at Leyden. There is also a Hebrew translation at the Bodleian Library.

[3584] D. Campbell: *Arabian Medicine;* op cit; p. 89.

[3585] Ibid.

[3586] Ibid.

[3587] Ibid; p 90.

[3588] Derived from M.S. Spink and G.L. Lewis: *Abulcasis on Surgery*; op cit;

surgeon sought to extract a large stone from a man of advanced age, but rushed the operation and took out the stone but also part of the man's bladder; the man was dead three days later. Another surgeon bound a fracture over a wound of a boy very tightly with pads and splints, not allowing the wound to breathe, which eventually caused the leg and foot to swell. Al Zahrawi was called for help. He made the bandage loose, but gangrene had already appeared and spread; and the boy eventually died. Al-Zahrawi then relates another case:

> 'I saw another Doctor incise a malignant tumour. After some days the place broke out in open ulceration; thereby adding to the misery of the patient. For a cancer that arises from a melancholic humour should never be touched by the knife unless it should happen to be in a part of the body which may be removed thoroughly and in its entirety.'

Extreme accuracy in diagnosis and treatment, but also treatment according to patients and particular situations, he insists, are fundamental (p. 128 ff.) He, thus, describes and prescribes cauterization for deformities, but insists that cauterization should be avoided if deformities arise from nervous spasms. Another precautionary measure (in Book One on cauterisation) is the need to consider the general state of the patient first; and that some operations under certain conditions should be avoided as much as possible. In Chapter I of Book Three he draws attention to the differences in patients imposed by their age and condition, and also to the difference in fractures either with respect to the limb affected, or the nature of the fracture itself. To each type, he gives detailed directions, and the way to bandage. In the cure of hydrocephalus (p. 170), he gives directions for surgery if the swelling is small. If on the other hand, it is large, he gives alternatives, and if the problem is not between the bone and skin, but beneath the bone, he advocates a further course of action. He concludes his directions with the usual procedures to follow after the operation, and what particular diet is suitable for the patient.

Al-Zahrawi was possibly the first surgeon to understand how malignant diseases spread wide and fast, and the need for radical surgery. Thus on cauterization of cancer (p. 150), he advises burning all around the circumference of the cancer. Some doctors, he says, only advise extensive cauterization in the middle, which is wrong as the cancer ulcerates out, which he had seen several times. The same with gangrene (p. 154,) where he advises cauterization all over till all corruption is eradicated and none remains. And on amputations of limbs from gangrene (pp. 576-8), he stresses radical, prompt surgery. However, he is careful to point that if

disease had reached the shoulders, amputation like with other limbs (fingers, hand, arm etc..) will cause the death of the patient. Instead he recommends the use of other means as well as possible. Similarly (p. 460) a cancerous tumour arising on the uterus is under no circumstance to be treated with the knife.

Al-Zahrawi insists (as in p. 146) that operations should only be undertaken by experts. Hence on cauterization for numbness, he stresses that the operation could only be attempted by someone who has good knowledge of the anatomy of the limbs and of the exits of the nerves that move the body. And (p. 420) on the extraction of a stone from a female, he recommends, that when carrying out the operation female assistance is crucial.

Al-Zahrawi also gives great attention to teeth problems and diseases and ways of curing them. (Pp. 272-4) he draws attention to the corruption of the teeth by substances that attack the gums. He recommends scraping teeth with a metallic instrument. He also notes that the tool used for the inner surface of the tooth is different from that used for the outer surface, and another one for scraping between the teeth, and all instruments are illustrated. (P. 276), he insists that all must be done to keep the tooth (a noble substance) until there is no means of avoiding its extraction. (P. 292), he tells of interlacing loose teeth with silver and gold wire; preferably gold as it does not oxidize or corrode, and lasts for ever.

On circumcision (pp. 396-400) he recommends the use of scissors and ligature. He says that the small boy must be kept unaware of what was happening, amused and cheered as best as possible, and for the surgeon to keep the scissors out of the boy's sight.

A whole chapter (46, pp. 346-61) includes descriptions and illustrations of instruments for incising and perforating. And from such illustrations can be noted the immense similarity with modern day instruments used for the same purposes. In the use of the scalpel and cutting instruments, Al-Zahrawi shows how incisions are to be made (as with the eyes, p. 188), the direction of the cut, depth, the care needed to avoid muscles etc. He also shows in detail how to use knives during surgery (pp. 644, 646, 650,) again how to cut, the direction, depth, length, nature of the cut etc. Towards the end (pp. 698-710), he deals with fractures of the head caused by swords or stones, haemorrhages, and what instruments to use in each situation, and what sort of bone is dealt with. He insists constantly on the extreme care to be taken in using instruments in sensitive areas.

Al-Zahrawi repeatedly insists on the precautions to be taken to avoid cutting veins and arteries, and not to injure badly the part being operated upon, especially the eye or the brain (p. 208). On the extraction of temporal arteries, where the risks of haemorrhage are high, the operation is looked at in every minute detail, every action carefully described, as well as ways of dealing with bleeding and healing the wounds. To perform such highly delicate operations, Al-Zahrawi insists very much upon the need for broad sunlight, and the operation to be carried out in the middle of the day.
Haemorrhages are of course frequent in surgery, and constitute a very important element of his care. Thus, (p. 162) he elaborates on how to deal with haemorrhage arising from a cut artery. Every single action is detailed (pp. 162-4): how to close arteries; use of cauterization; use of strong thread ligature and bandaging in extreme cases; the use of very cold water to thicken the blood and make it congeal; and so on and so forth.

On the use of diverse substances necessary to complement surgery, al-Zahrawi mentions treatments which generate flesh, such as the mixing of wheat flour, colophonia, and making a salve of them to encourage the growth of flesh. The use of plants and their derivatives, honey, and ointments are also considered for cleansing or healing wounds, stopping bleeding, helping skin regeneration, and even opening wombs (p. 496). He also (p. 694) describes a plaster made of mill dust which, he says was principally flour, made into a stiff paste with egg white. He directs its use in instances of fractures of the clavicle and forearm.
Suture captures Al-Zahrawi's interest in all its applications. He decribes its use after operations and the material it is made of: 'rubbed down and well cleansed gut' (pp. 266, 334, 450, 536 etc.).

The greatest merit of Al-Zahrawi is not what he says, but the way he says it, never refraining from being detailed, repetitive, and above all very precise. Thus, as an instance, his focus on blood vessels absorbs thirty pages (pp. 624-54); dealing with vessels that can be opened; describing precisely their location, the number of veins in each limb etc.

Al-Zahrawi uses countless examples throughout his work, describing what he saw, what happened, what he did, what precautions were taken, before, during, and after the operation; how to cover wounds and cuts; how to loosen the bandage, rinse the wound, apply balms and other treatments until the wounds heal and so on and so forth; a mass of details no surgeon can miss. He devotes, for instance, an extensive amount of writing (pp. 608-22) to the single operation of extracting arrows. He describes their wounds; the reactions according to each wound in any part of the body; when the

wounded person should not be operated upon, accounts of arrows he has himself extracted from patients, and so on and so forth.

Throughout the work, Al-Zahrawi also insists on actions that today might be taken for granted, but which at the time were fundamental for the success of surgery, such as the time of the day when operations should be undertaken, and when to avoid performing surgery. He tells how to sit or place the patient for each operation, the diet before and after the operation, the work of the assistants, the ways to heal wounds, to regenerate skin, and care for bones, actions to take in case of haemorrhage, etc. (P. 324,) for instance, he explains that even when releasing the pus from an abscess or wound, great attention should be paid to the state of the patient: too much and too sudden evacuation, and the patient might die. He also draws attention to the simple and yet important acts of having ready sponge or linen towels to wipe the blood away; and wiping off continuously during operations.

Al-Zahrawi (pp.578-80), does not fail to narrate his own shortcomings such as when he amputated the foot of one of his patients, then refused to amputate the hand when the disease affected it despite the insistence of the patient, because he considered him too weak to withstand the new operation. The patient went back to his country and there he had his hand amputated, and recovered. Al-Zahrawi narrates this story to his sons (students) so that they would see in it guidance to take and act upon; and that however great the surgeon, there is always someone better.

Finally, relying on his experience, Al-Zahrawi does not hesitate to refute the Ancients' methods, and he proposes better ways, such as here with regard to suture. The Greeks seem to have employed only wool or linen, whilst Al-Zahrawi uses gut for mending wounds of the intestine, but first he tells us of another technique (p. 550):

> 'Some men of experience have said that when a wound occurs in the intestine and it is small, it should be sutured in this manner. Ants with large heads are taken, then the edges of the wound are brought together and one of these ants is applied by its open jaws to the two edges of the wound. When it seizes it and closes its jaws, the head is cut off. Then another ant is applied near the first, and so on. The heads will remain sticking to the intestine until it is healed, and no harm will come to the patient.'

Then he says:

> 'The intestine may also be sewn up with the fine suture which is extracted from an animal's gut. The end is taken of this suture,

> well scraped, and to it is fixed a fine linen thread, twisted, which is passed through the needle. The intestine is sewn with the gut, then replaced in the abdominal cavity.'[3589]

Al-Zahrawi also refutes the Ancients in relation to many other issues such as in the treatment of dislocations of the spinal vertebrae (p. 812):

> 'If the curvature dates from childhood, there is no treatment or cure at all. As for the sort that occurs from a fall or a blow or the like, the Ancients indulged in lengthy disquisitions, giving many kinds of treatment, most of which are of no use. I have abbreviated, making a little which will serve in place of their much, consisting in my clarification and exposition of the sense. I have also depicted the instrument differently from theirs.'[3590]

In view of these examples cited, and other extracts in his work, it is obvious that he is at odds with Greek surgery, and his surgery is much more advanced, closer to our modern surgery. Thus, the assertion made by Western historians (as seen in the first heading) that Al-Zahrawi's surgery is Greek, is false. Similar conclusion is reached by Haddad, who answers the assertion that Al-Zahrawi's surgery is based on Paul of Aegina's by noting that 'those who hold this opinion have not compared the works of the two men.'[3591]

b. Eye Surgery:

In eye surgery, the Muslims were not surpassed for several centuries.[3592] Nearly every Islamic medical compendium covers some aspect of eye diseases, although the best are monographs solely dedicated to the subject.[3593] Such works on ophthalmology were innovative in many ways.[3594] One reason, possibly, for the advance of the science was its high incidence amongst the population, and the fact that Muslim eye surgeons were able to use freely available eyes for practice.[3595] Another, very likely reason, is that, as with surgery in general, though the oculist was not regarded with much respect among the Greeks and Romans, in Islam, he

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[3589] See G. Lewis: *The Surgery of Al-Zahrawi;* op cit; p. 30.
[3590] Ibid; p. 34.
[3591] Haddad Quoted by R.H. Major: *A History*; op cit; pp. 251-2.
[3592] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 49.
[3593] E. Savage Smith: Medicine, in the *Encyclopaedia* (Rashed ed), op cit, pp 903-62. at p. 948.
[3594] G.M. Wickens: The Middle East, op cit, p 116.
[3595] Ibid.

was an honoured member of the medical profession and occupied a unique place in the royal household in the days of the caliphs.[3596]

The first scientific treatise on ophthalmology was written by Yuhanna ibn Massawaih (777-85) under the title *Daghal al-'Ain*, or *Disorder of the Eye*, one copy of this manuscript is preserved in the Taimur Pasha Library in Cairo, while another copy of it is found in the Leningrad Library.[3597] The other important early work on the subject is the *Ashar Maqalat fi'l Ain* or the Ten Treatises on the Eye by Hunayn Ibn Ishaq (809-77), which is duly illustrated with diagrams, and in which Hunayn discusses the anatomy of the eye, brain, and optical nerves, as well as physiology, diseases and treatment of the eye.[3598] Max Meyerhof has made an excellent edition and translation of the work into English, accompanied by a glossary.[3599]

Most famed of all Muslim oculists is Ali Ibn Issa (Jesu Haly) (d.1010), from Baghdad, who completed *Tazkiratul-Kahhaleen* (Notebook of the Oculist) on diseases of the eye.[3600] The first part of it is devoted to anatomy, the second to the external diseases of the eye, and the third part to internal diseases of the eye which are not visible upon inspection.[3601] When 'Ali speaks of internal diseases of the eye, he literally means diseases confined to the eye. The possibility of first diagnosing diabetes, kidney disease and cerebral tumour in the ophthalmic consulting room was not conceived of by the oculists of those times.[3602] The nearest approach that 'Ali makes to the modern conception of eye disease as a manifestation of general disease is when he urges the practitioner to realise that defective vision may be due to a disease of the stomach or brain just as much as to an incipient cataract.[3603] The book contains the first description of the disease of temporal/giantcell arteritis which causes severe headache, migraine, loss of appetite and inflammation of the temporal muscles.[3604] These symptoms sometimes terminate in the loss of

[3596] F. Farag: Why Europe responded to the Muslims medical achievements; in *Arabica,* XXV, Fascicule 3; pp. 292-308. p. 297.
[3597] Khairuddin al-Zirikli: *Al-Alam;* 9th edition; Beirut; vol viii; p. 211. in Abdul Ali: The Arab-Muslim Legacy to Ophtalmology; in *Islamic Culture*; op cit; pp. 59-67 at p. 59.
[3598] Abdul Ali: The Arab-Muslim Legacy; op cit; p. 59.
[3599] M. Meyerhof: *The Book of the Ten Treatises on the Eye Ascribed to Hunain Ibn Ishaq* (Government Press; Cairo; 1928).
[3600] With the Latin title of *Tractatus de oculis Jesu Hali.*
[3601] F. Farag: Why Europe; op cit; p.300.
[3602] Ibid.
[3603] C. Elgood, *A Medical History of Persia;* op cit; p. 141.
[3604] Abdul Ali: The Arab-Muslim Legacy; op cit; p. 61.

sight. Thus, he was also the first to note a relationship between inflamed arteries and visual symptoms, not only in the case of a migraine, but also in affections showing heat and the inflammation of the temporal muscles.[3605] He suggests the removal and cauterisation of the artery as a treatment for this disease.[3606] The credit for the discovery of this disease has wrongly been given to Sir Jonathan Hutchinson and James Horton. Hutchinson (1828-1913), an eminent British surgeon and pathologist, was an authority on eye and skin diseases,[3607] while Horton served as a medical officer in the British Army between 1857 and 1871.[3608] This error was first corrected by J.R. Hamilton and his colleagues in an article titled Giant Cell Arteritis including Temporal Arteritis'.[3609]

A point of great importance in Ali Ibn Issa's treatise relates to its use of the expression *Tanwim* (sedate) the patient. According to Hirschberg Ibn Issa speaks of general anaesthesia in four places, in operations for hydatids of the eyelids, he remarks: In case the patient is one of those who can't hold still and causes trouble, put him to sleep and let one assistant hold his head and the other his arm.'[3610] This breakthrough (like many) was not accepted to be of Islamic origin by historians who claimed it might just mean asking patients to lie down.[3611] The Muslims, however, knew a great deal about the issue. Baha-al-Dula wrote:

> 'Take care that the treatment (the anesthetic) is not more dangerous than the disease."[3612]

Ali Ibn Issa's work was translated once into Hebrew and twice into Latin, and was printed in Venice in 1497, 1499, and 1500.[3613] Centuries later, it was translated with commentary into German by Hirschberg and Lippert (1904) and into English by Casey Wood (1936).

A contemporary of Issa Ibn Ali was Ali Ammar Al-Mosuli, whose *Kitab-ul Muntakhab fi Ilaj-ul Ayn* (Book of Choices in the Treatment of Eye Diseases) discusses forty eight diseases, clinical cases and adaptations of

[3605] Ibid.
[3606] M. Q. Mohammed: *Fi Tadhkirat al-Kahhalin*; in the Journal *al-Arabi* (Kuwait; No 284, July 1982); pp. 171-3.
[3607] Encyclopaedia Britannica; vol VI; p. 176; in Abdul Ali: The Arab-Muslim Legacy; p. 61.
[3608] Ibid.
[3609] Which appeared in the American Journal Medecine; vol I; No 1 (January 1971), in Abdul Ali: The Arab-Muslim Legacy; Note 8; p. 66.
[3610] R.H. Major: *A History of Medicine*; op cit; p. 247.
[3611] E. S Smith: Medicine, in *Encyclopaedia* (Rashed ed) op cit, p 950.
[3612] Casey Wood: *Memorandum Book of a Tenth Century Oculist, (*Northwestern University, Chicago, 1936), cited by C. Elgood: *A Medical History; op cit.* p. 281.
[3613] As *Tractatus de oculis Jesu Hali.*

surgical instruments.[3614] The book deals with the anatomy and pathology of the eye. It mentions six cases of operation for cataract, deals with diseases of the eyelid, the corner of the eye, the conjunctive, the cornea, the pupil, the albumen, and the visual nerves.[3615] In discussing the treatment of a cataract, Al-Mosuli produces an instrument of his own design, a hollow needle, which he introduces through the sclerotic, extracting the lens by suction.[3616] This avoided an incision into the anterior chamber and the consequent loss of aqueous humour.[3617] The treatise of Ali Ammar on eye surgery, according to Meyerhof, is so rich, that only in the 19th century did Western European treatises catch up with it.[3618]

A number of other medical authors dealt with the same subject. Ibn Sina's section dealing with ophthalmology has been a particular subject of interest on the part of modern medicine.[3619] Al-Ghafiqi (d. 1165) wrote *Al-Murshid fil Kuhl* (The Right Guide in Ophthalmology), also gives details of the head and diseases of the brain, which he illustrated with pictures of the surgical instruments he used in performing eye operations, a practice started by al-Zahrawi.[3620] Salah Eddin of Syria *Kitab Nur al-uyun wa-Jami al-Funun* (Light of the Eyes..) is a very good compendium on previous authorities in the field.[3621] Another Syrian, Ibn Abi'l-Mahisin, who lived in Aleppo until about 1256, was the author of *al-Kafi fi 'l-Kuhl,* or The Sufficient Manual on Collyrium.[3622] His writings contain a useful introduction to eye surgery and descriptions of eye operations, side by side with diagrams and drawings of surgical instruments.[3623] He mentions eighteen major ophthalmologic texts, where he makes good descriptions of cataract operations, and the instruments used, as well as the steps to be taken after operations.[3624] He was one of the foremost eye surgeons of his

[3614] E.S. Smith: Medicine; op cit; p 949.
[3615] F. Farag: Why Europe; op cit; p. 299.
[3616] Ibid.
[3617] Ibid.
[3618] A. Mieli: *La Science Arabe*; op cit; p.125.
[3619] F. Gabrieli: the Transmission of learning and literary influences to Western Europe, In *The Cambridge History of Islam*, Vol 2, ed P.M. Holt et al (Cambridge University Press, 1970), pp 851-89 at 862.
[3620] In The Genius of Arab Civilisation; p. 180 in Abdul Ali: The Arab-Muslim Legacy; op cit; p. 65.
[3621] M. Levey: *Early Arabic*, op cit, p. 129.
[3622] Abdul Ali: The Arab-Muslim Legacy; op cit; p. 63.
[3623] Ibid.
[3624] M. Levey: *Early Arabic*, op cit, p. 129.

time, and was so confident in his skill that he did not once hesitate to operate, even upon a one-eyed patient to remove a cataract.[3625]

A number of diseases, not yet cited, were dealt with by these eye-surgeons. Amongst these was pannus, the Muslims being the first to operate for the relief of its chronic form.[3626] In his *Diseases of the Eyes*, Ibn Massawayh describes the surgical treatment of pannus, how the surgeon would lift the blood vessels over the pupil with a small hook, and then sever them.[3627] Ibn Massawayh also describes surgical operations on the eyelids and the sutures that were used.[3628]
Muslim surgeons also differentiated phlyctenulae from corneal ulcers, whilst circumcision of the conjunctiva as an operation was revived in 1862 by Funari, who was given credit for a new method of treatment, which was, in fact, centuries after the Muslims had used it.[3629]

In respect to the cataract, finally, Muslim surgeons stated that it was due to a pouring out of humour into the eye. Before them, Celsus had stated that suffusion is characterized by corrupt humour, collected in the locus vacuus between the pupil and the lens, thus abstracting the visual power. By clearing this empty space vision could be restored.[3630] The same attention to detail is found again with al-Zahrawi, for instance, who, on the couching of the cataract (pp. 252-6), says that, although the patient's sight can be tried, it must not be at the time of the treatment, or immediately after the perforation by the needle. Here again (p. 256), he mentions of the existence in Iraq of the hollow needle to extract cataract (by sucking it out).[3631]

[3625] P.K. Hitti: *History of the Arabs* (London; 1970), p. 686.
[3626] A. Whipple: *The Role*; op cit; p. 68.
[3627] R. Arnaldez-L.Massignon: Arabic Science; op cit; p. 419.
[3628] Ibid; pp. 419-20.
[3629] A.Whipple: *The Role*; op cit; p. 68.
[3630] F. Farag: Why Europe; op cit; p. 298.
[3631] Note p. 256 by M.S. Spink and G.L. Lewis to the Englishman Woolhouse (1666-1744) who invented similar needle (that sucks cataract), which he called a *paracentharium oculi*, and which was described in the *Paris Journal des Savants* xii. ii (1696).

7. Hospitals:[3632]

Whilst travelling in the Near East in the years 1183-5, Ibn Jubayr noted one or more hospitals in every city in the majority of the places he passed through, which prompted him to say that hospitals were one of 'the finest proofs of the glory of Islam,' (and the madrasas another).[3633]
Some twenty or so years before, in 1160, another traveller, Benjamin of Tudela, found no fewer than sixty well organized medical institutions in Baghdad.[3634] Earlier, in the Muslim West, it was said that there were 50 hospitals in Cordoba.[3635]

Possibly the earliest hospital in Islam was a mobile dispensary following the Islamic armies, dating from the time of the Prophet, a tradition which remained throughout the centuries of Islamic glory.[3636] The first known hospital in Islam was built in Damascus in 706 by the Umayyad Caliph, al-Walid Ibn Abd al-Malik. It was to cater for all sorts of patients including the blind, but also the lepers.[3637] The hospital, its equipment, its staffing and organisation, was to serve as model for other hospitals to follow throughout the Islamic world. Hence, in Baghdad, Caliph Harun al-Rashid (r. 796-809) ordered the court physician to build the Baghdad hospital, a vast endeavour he financed generously, whilst Caliph Al-Mansur (r. 754-775) instructed his court physician, Ibn-Bakhtishu to set up hospitals to 'reflect the true glory and prosperity of Baghdad.'[3638] In Cairo, the first hospital was established at al-Fustat by Ibn Tulun, governor of the city in 872. It included a library of 100,000 books,[3639] and had halls divided according to genders, illness, or the required surgical operation, and two separate baths for men and women.[3640] After admission, each patient was required to wear special apparel provided by hospital authorities, while personal possessions were safely kept until the

[3632] See A Issa Bey: *Histoire des hopitaux en Islam*; op cit.
[3633] Ibn Jubayr: *Travels,* op cit, Vol 3, p. 330.
[3634] Rabbi Benjamin of Tudela, *Itinerary,* Vol. I (New York), p. 99.
[3635] R.H. Major: *A History of Medicine*; op cit; p. 260.
[3636] A. Djebbar: *Une Histoire*; op cit; p. 319.
[3637] G. Wiet et al: *History;* op cit; p. 651.
[3638] E. Abu Leish: 'Contribution of Islam to medicine' in *Islamic Perspective*, op cit; pp. 15-44. p 22.
[3639] F.S. Haddad in I.B. Syyed: Medicine and medical education in Islamic history, in *Islamic Perspectives*; op cit; pp 45-56, p. 48.
[3640] S.K. Hamarneh: *Health Sciences in Early Islam*, 2 vols, edited by M.A. Anees, vol I (Noor Health Foundation and Zahra Publications, 1983), p. 101.

day of discharge.[3641] In Tunisia, the Aghlabid ruler, Ziyadat Allah I (r. 817-838) built a hospital in Al-Qayrawan in 830, where for the first time in history, female nurses were used. It also had a mosque, spacious wards, its services well indicated for visitors, and waiting rooms for both visitors and patients.[3642]

More hospitals were erected, and by the 12th century, the institution of the hospital in Islam had reached very advanced standards as seen in these instances. In Damascus, the largest hospital, built in 1156 by Nur Eddin Zangi, the Al-Nuri Hospital, was placed under the direction of the physician al-Bahili. It was well supplied with food and medication, and had a well stocked library for teaching.[3643] Ibn Jubayr admired most particularly the way in which the administrator of the hospital kept a register of patients,[3644] probably the earliest of its kind.[3645]
In Morocco, in 1190, the Almohad ruler, Al-Mansur Ya'qub Ibn Yusuf built a hospital in Marrakech in a spacious area surrounded by fruit trees, flowers, herbs, and vegetables.[3646] In this hospital, the historian al-Marrakuchi says, 'water was brought in aqueducts to all its sections, besides four pools in the centre thereof, of which one was built of white marble.'[3647] The daily endowment was thirty golden dinars for the purchase of food supplies, un-stocked medication, and unpredicted expenses.[3648] Physicians cared for the sick and prescribed diet and medications, while appointed pharmacists specialised in the compounding and preparing of drugs. Here, too, patients were provided with special apparel for the summer and winter seasons.[3649]
In Cairo, the Mamluk sultan Qalawun (d. 1290) began the construction of al-Mansuri Hospital, the largest of all.[3650] Masons and carpenters were brought from all parts of Egypt; loiterers in the street, and passers by, whatever their rank were obliged to assist in the holy work.[3651] When completed, in 1284, this hospital attended 4000 patients daily, had

[3641] Al-Maqrizi: *Khitat,* vol 2, p 405.
[3642] S. Hamarneh: *Health Sciences;* op cit; p. 102.
[3643] S.K. Hamarneh: *Health Sciences; op cit.* p. 100.
[3644] Ibn Jubayr: *Rihlat,* op cit, pp 283-4.
[3645] S.K. Hamarneh: *Health Sciences*, op cit; p. 100.
[3646] Abd al-Wahid al-Marrakushi: *Al-Mu'jib fi Talkhis Akhbar al-Maghrib*, R. Dozy, ed (Leiden, 1881), 208-10 in S.K. Hamarneh: *Health*, op cit, p. 103.
[3647] Ibid.
[3648] Ibid.
[3649] Ibid.
[3650] E.T. Withington: *Medical History From the Earliest Times* (1894); p. 166.
[3651] E.T. Withington: *Medical*; p. 166; D. Guthrie: *A History of Medicine*; op cit; p. 96.

different wards for diverse diseases, and even applied music therapy on mentally ill patients.[3652] Al-Mansuri is described by Durant:

> 'Within a spacious quadrangular enclosure four buildings rose around a courtyard adorned with arcades and cooled with fountains and brooks. There were separate wards for diverse diseases and for convalescents; laboratories, a dispensary, out-patient clinics, diet kitchens, baths, a library, a chapel, a lecture hall, and particularly pleasant accommodations for the insane. Treatment was given gratis to men and women, rich and poor, slave and free; and a sum of money was disbursed to each convalescent on his departure, so that he need not at once return to work. The sleepless were provided with soft music, professional story-tellers, and perhaps books of history.'[3653]

Major adds that the income devoted to this hospital by the Mamluk rulers was the equivalent of $100,000 a year, and that each patient received the equivalent of $12 (1954 value) on their dismissal from the hospital.[3654]

Pushmann acknowledges how the Muslims developed the hospital institution on efficient lines.[3655] Muslim hospitals, indeed, were managed according to standards that compare favourably with those of today. Nearly all hospitals had separate wards for male and female patients, with different wards for the different therapeutic branches, such as medicine, surgery, orthopedics and eye diseases.[3656] A separate ward or pavilion, with barred windows, was used for the care of the mentally ill, whilst a pharmacy, in the charge of a competent and licensed pharmacist, was used for both the Out-Patient and In-Patient services.[3657] Care for the patients was not just during stay at hospital, but also after. At Al-Mansuri of Cairo, for instance, patients on discharge, were given food and money to help them compensate for lost income during illness.[3658] The position of the director of the hospital was considered one of the highest in the government, and as a rule was assigned to one of the princes, or an officer of the highest rank, and as a rule these were men of ability and culture, greatly respected, and ranking with the vizier or minister.[3659] Al-Razi, Ibn

[3652] F.S. Haddad in I.B. Syyed: Medicine and medical education; op cit; p. 48.
[3653] W. Durant: *The Age of Faith*; op cit; pp 330-1.
[3654] R.H. Major: *A History of Medicine*; op cit; p. 260
[3655] T. Puschmann: *History of Medical Education;* English tr by E.H. Hare (London; 1891), p. 145.
[3656] A. Whipple: *The Role*; op cit; p.81.
[3657] Ibid.
[3658] Al-Makrizi: *Khitat*, vol 2, op cit; p 405.
[3659] A. Whipple: *The Role*; op cit; p. 81.

Sina and Ibn Zuhr, amongst others, worked both as hospital directors and deans of medical schools.[3660] The hospitals also housed staff and students, whilst physicians were paid with regular salaries, and governmental budgets covered expenses.[3661] Islamic chroniclers kept accurate accounts concerning the administration of the hospitals in Baghdad, which allows us to have records of their budgets, including salaries of the physicians, oculists and attendants.[3662]

Hospitals were the perfect symbol of universality of health care in Islam, and unlike their successors elsewhere, they catered for the needs of all, rich and poor alike, in urban and in rural areas, and freely. This attitude derives directly from the Qura'nic text which imposes upon the believer to give care and cure to every human regardless of their rank in society, including slaves.[3663] For instance, Ibn Abi Usaybi'a speaks of an eminent Syrian doctor of the 12th century, who, after examining the sick in the hospital, went to court to treat the important people.[3664] The constitution establishing the Al-Mansuri hospital in Cairo, also talks of its duty is to give care to the ill, poor, men and women until they recover, without demand for any form of payment, but only for the sake of God, the Provider.[3665] There was no distinction for faith or race either, whether in the provision of care or in the staffing of the hospitals. Staff came from every background, Christians, Jews, and others, often holding the highest authority in the institution. Sarton's *Introduction* is an excellent window on such multi-faith diversity in Muslim hospitals.[3666]

Hospitals were places of care and also of learning and training. Hence, the leading figures of Islamic medical science who worked as directors of hospitals also took the lead in generalising the practice of studying patients and preparing them for student presentation.[3667] At al-Nuri hospital of Damascus, teaching and discussions on topics related to medicine were conducted by people of great renown.[3668] Some of the physicians at al-Adudi in Baghdad took on the task of teaching 'interns'

[3660] I. B. Syed, Medicine, op cit, p. 45
[3661] S. Hamarneh: *Health Science;* op cit; pp 100 ff.
[3662] R.H. Major: *A History of Medicine*; op cit; p. 232.
[3663] Cited in A.Djebbar: *Une Histoire;* op cit; pp 318-9.
[3664] Ibn Abi Usaybi'a '*Uyun*, p. 628 in F. Micheau, The Scientific Institutions, op cit, p. 1001.
[3665] A. Isa Bey: *Histoire des hopitaux; op cit;* p. 151.
[3666] G.Sarton: *Introduction,* Vols I and ii in particular.
[3667] I. B. Syed: Medicine, op cit, p. 45
[3668] Ibn Abbi Ussaybi'ah: '*Uyun al-anba' fi Tabaquat al-Attiba*, edited by A. Mueller (Cairo/Konigsberg; 1884, reprint, 1965), vol 3, pp 256-7.

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[3666] G.Sarton: *Introduction*, Vols I and ii in particular.
[3667] I. B. Syed: Medicine, op cit, p. 45
[3668] Ibn Abbi Ussaybi'ah: *'Uyun al-anbd fi Tabaquat al-Attiba*, edited by A. Mueller (Cairo/Konigsberg; 1884, reprint, 1965), vol 3, pp 256-7.

and students of medicine.[3669] In some of the famous hospitals there was a large hall, containing manuscripts, where the professors met undergraduate and graduate medical students for lectures and conferences.[3670] At Al-Mansuri, in Cairo, there was a place where the head doctor gave lectures on medicine.[3671] The hospital itself was manned by interns, residents and twenty four hour consultants, some of whom were specialists in ophthalmology, surgery and orthopaedics. They called on the patients and prescribed for each his daily requirements of diet and medication.[3672] In that hospital, there was on average one professor of medicine for every eighteen students in its early stages.[3673] The chief surgeons and physicians also gave demonstrations to students, examined them and issued diplomas.[3674] Al-Madjusi (d. 994) may be called the father of the medical 'intern' system, for he required that the student be present at the professor's examinations.[3675] He also insists:

> 'And one of those things which are more incumbent on the student of this art, are that he should constantly attend the hospitals and sick houses; pay unremitting attention to the conditions and circumstances of their inmates, in company with the acute professors of medicine; and enquire frequently as to the state of the patients and symptoms apparent in them, bearing in mind what he has read about these variations, and what they indicate of good and evil.'[3676]

As places of learning, the hospitals were also richly endowed with libraries. Nur Eddin Zangi (r. 1146-1174) constituted into waqf a large number of books on medicine for the Al-Nuri Hospital, which he had founded in Damascus.[3677] This collection was located in two specified spots at the entrance of the Iwan, and a group of physicians and hospital employees sat in front of al-Bahili Ibn Ubayd Allah, who then distributed books out from these two spots for reading.[3678] Exchange between students took place following the reading of such works for as long as three hours.[3679] Sultan Qalawun (Qala'un) (r. 1277-1290), after having the hospital constructed, had a madrasa built near it, and fitted it with a

[3669] Ubn Abi Usaybia: *Uyun al-Anba...* (Beirut, 1957), vol 2, 232-5; 248; 344.
[3670] A. Whipple: *The Role;* op cit; p.81.
[3671] Al-Makrizi, *Al-Khitat*, op cit, II, p. 406.
[3672] S.K. Hamarneh: *Health Sciences*; op cit; p. 99.
[3673] A. Djebbar: *Une Histoire;* op cit; 319.
[3674] R.H. Major: *A History of Medicine*; op cit; p. 232.
[3675] G. Wiet et al: *History;* op cit; p. 653.
[3676] R.H. Major: *A History of Medicine*; op cit; p. 241.
[3677] Y. Eche: Les Bibliotheques; op cit; p. 235.
[3678] Ibid.
[3679] Al-Safadi: *Al-Wafi bi'l wafayat;* Ms of Ahmad III; Istanbul; No 2920; l. V., 12 r.

library.[3680] He had a librarian appointed for 40 dirhems a month.[3681] Many scholars also dedicated works to such libraries. Ibn Al-Nafis, for instance, made his house into a waqf, and gave his books to the al-Mansuri Hospital,[3682] which includes his major work *al-Shamil fi'l Tibb* in 300 volumes.[3683]

Having looked briefly at the Islamic hospital, which in its main features and operations, reflects the modern day hospital, we can safely assert, that this institution was born under Islam, and not under some previous civilisations,[3684] which at no instance shows one single advanced form of management or operation, or state involvement, as was the case with the Islamic hospital. Watts insists that we should remind ourselves that in earlier times, in the world of Greece and Rome, there had been no such a thing as hospitals for ordinary people.[3685] Houses for refugees and the afflicted certainly existed, but hospitals run, organised and providing care in the modern sense, as in the Islamic world, certainly did not.

The best Islamic hospitals, Whitty says, were several centuries in advance of European ones, although to what extent they directly influenced European practice is difficult to quantify.[3686] Meyerhof, however, makes an outline of the Islamic impact upon the Christian West in this field, stressing the role of the crusades.[3687] Western hospitals, he notes, may well have been imitations of such splendidly installed 'Bimaristans' as that of the contemporary Seljuk ruler Nur Eddin in Damascus.[3688] The Mansuri hospital of Cairo was much admired by European travellers of later centuries.[3689] The asylum and hospital 'Les Quinze Vingt' was founded in Paris by Louis IX (St Louis) after his return from his unhappy crusade in 1254-60. Originally intended for three hundred poor blind men, it had added to it later a hospital for eye diseases which is now one of the most important in the French capital.[3690] In teaching methods, Muslim hospitals exerted a

[3680] Al-Makrizi: *Al-Khitat*; op cit; II; p. 407.
[3681] Al-Nuwayri: Nihaya; op cit; 30; r.
[3682] Al-Safadi: *Al-Wafi bi'l wafayat*; op cit; XX; p. 162; r.
[3683] Ibid; p. 162; r..
[3684] As found in G. E. Gask and John Todd: "The Origin of Hospitals," in *Science, Medicine* (E A. Underwood, edt; op cit; vol I; 1953.
[3685] S. Watts: Disease and Medicine; op cit; p. 49.
[3686] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 48.
[3687] M. Meyerhof: Science and medicine, op cit; at pp 349-50.
[3688] Ibid.
[3689] Ibid.
[3690] Ibid.

strong influence, and Muslim methods with teaching ward rounds in clinical medical schools have been re-discovered many times, from the School at Salerno to Sir William Osler (a great admirer of Ibn Sina) at the end of the 19th century in Canada, the USA and Britain.[3691] They remain the standard method of teaching Western medicine to this day.[3692]

The hospital institution in its rise reflects the glory of Islamic civilisation. In its collapse it also reflects the collapse of the same civilisation. In 1258 the Mongol Hulagu conquered Baghdad and made the illustrious Addudi hospital the centre of his attack.[3693] When the traveller, Ibn-Battuta, visited Baghdad in 1330 he found the place in complete ruin, only traces of the walls were left.[3694] That was also the fate of the city, from once being the glory of Islamic civilisation, now there was barely a trace of it.

[3691] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 48.
[3692] Ibid.
[3693] A. Whipple: *The Role* ; op cit ; p. 86.
[3694] Ibid.

PHYSICS AND OPTICS

Moody notes how:

> 'Until the present century, historians of science have taken it for granted that Galileo did not have any predecessors of importance, and that the Aristotelian dynamics had been uncritically accepted throughout the entire medieval period. This is now a mistaken notion.'[3695]

Palter goes in the same direction stating that:

> 'The picture of the middle ages as one long period of intellectual darkness unmarked by any significant scientific advances can no longer be seriously maintained. Especially in physics and cosmology will the often acute medieval discussions and controversies come as a surprise to students brought up to believe that modern physics was born in the fertile brain of Galileo.'[3696]

To Moody's and Palter's observations can be added others, which once more denounce this generalised notion, that in ten centuries or more, from the 5th century to the so called Renaissance (16th-17th century), there was only scientific darkness. This generalised depiction of history does not just ignore ten centuries, calling them the Dark Ages, it also erases every trace of the Islamic role in the subject. This is compounded by the fact, that, of all sciences, there is not one single book on Islamic physics. Not that facts cannot be gleaned, for they exist in original, primary sources, and are also scattered in old secondary sources, most particularly. The state of Islamic physics today is precisely the same as that of Islamic technology and Islamic agriculture until recently, when, at last, Hill brought Islamic technology out of its slumber, and Watson did the same for agriculture. Islamic physics awaits similar attention.

[3695] E.A. Moody: Laws of motion in medieval physics, in *Toward Modern Science*, edited by R.M. Palter (The Noonday Press, New York, 1961).
[3696] A. Palter: *Toward Modern Science*; op cit; preface, p. ix.

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This work, however, is not going to remedy the problem. Such a task demands the application of an expert mind in physics, lending his or her attention to dusting off old sources, translating passages from Arabic sources, studying, and putting together all the scattered material into some sort of comprehensive treatise, to be the first to illuminate on this science. What will be attempted here is a general overview of the subject, seeking to first look at issues (by no means all) that relate to physics (excluding optics), and then give some attention to optics on its own.

1. The Rich (Open) Field of Islamic Physics:

McGrew notes how, in 'contemporary usage, the word 'physics' denotes an autonomous and highly specialised branch of science which deals with the behaviour of non living systems, bringing them under the scope of the most general natural laws.[3697] There was no parallel to this discipline in medieval Islam; yet from the 8th century onwards there was a profusion of translations, commentaries and learned writings on topics which would today fall under the broad heading of physics.[3698] One of the early Islamic scholars who classified sciences, Al-Farabi (874-950), included amongst his works a Book of High Reasoning on Elements of the Science of Physics *(Kitab maqalat al-Rafi'a fi usul ilm al-tabia,)* a treatise on Vacuum (*Kalam fi'l Khala,)* a work on optics, and the Great Book of Music (*Kitab al-Musiqa al-Kabir).*[3699] More subjects are integrated within Islamic 'physics,' which, as succinctly summarised by Djebbar, includes in its various branches, statics, dynamics, and optical geometry, to which must be added what the Muslims call *Ilm al-Hayal* (ingenious devices) (seen above under technology).[3700] Mc Grew also points out that Islamic scholars wrote profusely on the nature of matter, causality, the theory and practice of mechanics and dynamics.[3701] Djebbar also refers to Al-Biruni *Maqala fi n-nisab* etc (Treatise on the Relation that Exists Between Metals and Precious Stones); Al-Khayyam: *Rissalla fi'l-ihtiyyal...* (Treatise on the Process for the Determination of the Weight of Gold and Silver in a Body

[3697] T.J. MC Grew: Physics in the Islamic World, in *Encyclopaedia* (Selin ed); pp 819-22; p. 820.
[3698] Ibid.
[3699] B. Rosenfeld and E. Ihsanoglu: *Mathematicians,*op cit; p. 76.
[3700] A. Djebbar: *Une Histoire*; op cit; p. 241.
[3701] T.J. MC Grew: Physics in the Islamic World, op cit; p. 820.

Made of Both); and of course the better known (and more studied): Al-Khazini's (d. 1123): *Kitab Mizan al-Hikma* (The Balance of Wisdom).[3702]

The last mentioned subject, the balance, attracted much of the interest of Muslim writings. This, according to De Vaux, somehow forms 'a special science'.[3703] It is included in Al-Farabi's classification of sciences, and in Hadji Khalifa's study of weights from the medical perspective.[3704] The Banu Musa brothers, Qusta Ibn Luqqa, and Ibn al-Haytham all wrote on the Roman balance of unequal arms: The *Kariston*. In the first half of 11th century, the Syrian Elias bar Shinaya wrote a treatise on the balance dealing with coins, weights, and measures, and explaining the use of various kinds of scales.[3705]
Two of the earliest, and most interesting treatises on the subject are by Thabit Ibn Qura (d.901): *kitab fi sifat al-wazn wa ikhtilafihi* (Book on the Properties of Weight and non Equilibrium) and *kitab fi'l qarastun* (Book on Beam Balance), which deal with mechanics primarily.[3706] Gerard of Cremona translated this work into Latin in the 12th century under the title *Liber carastonis*. Until 1911, there existed three manuscripts of it, one at Berlin's Stadtbibliotheq, another at the Jesuit library in Beirut and the third at the India Office in London (MS. 767, VII, fols 198-208).[3707] The first two have been lost. The work by Thabit on the Balance brings to attention the sharp contrast in approach to the subject between Greeks and Muslims. Mc Grew notes that one of the simplest mechanical devices, the lever, had been investigated mathematically by Archimedes, who gave an elegant proof that the forces required to keep the unequal arms of a lever in balance were inversely proportionate to the length of the arms. In the course of his proof, Archimedes assumed that two equal weights located at different points on one arm of the lever produced the same effect as if they were both located at the midpoint between them-an assumption which is intuitively plausible but for which he gave no rigorous justification, whilst Thabit provides an intriguing argument for this assumption in his *Kitab al-Qarastun* (Book of the Balance).[3708]

[3702] A. Djebbar: *Une Histoire*; op cit; pp 253; 261; 268.
[3703] Carra De Vaux: *Les Penseurs;* op cit; p 180.
[3704] Ibid.
[3705] G Sarton: *Introduction;* vol I, op cit; p.697.
[3706] B.Rosenfeld and A.T. Grigorian: Thabit Ibn Qurra, *Dictionary of Scientific Biography;* op cit, vol XIII, pp 288-95.
[3707] K. Jaouiche: *Le Livre...* op cit, pp 2-3.
[3708] T.J. MC Grew: Physics in the Islamic World, op cit; pp. 820-1.

The subject of tides also attracted a wide focus of Muslim writers from the earliest times, the Muslims insisting on the correlation existing between the phenomenon of high and low tide and the course of the moon.[3709] They became familiar with this, and the explanation given of it in the 9th century by Abu al-Ma'ashar (Albumazar) in his '*Introductorium magnum ad Astronomiam*', according to Duhem (by no means a fervent admirer of things Islamic), remained a classic throughout the Middle Ages.[3710] Al-Kindi and al-Biruni pursued this tradition, the latter explaining that the increase and decrease in the height of the ebbs and tides occurred in cycles on the basis of changes in the phases of the moon. He gives a very vivid description of the tide at Somnath, and traces the latter's etymology to the moon.[3711]

Magnetism also attracted early Muslim scientists including among them Jabir Ibn Hayyan (8th-9th century). The magnetic compass was soon widely used by Muslims for navigation purposes.[3712] Wiedemann has early in the 20th century made studies of the subject.[3713] More recently, Schmidl wrote a very good article on the use of the magnetic compass in the Islamic world, focusing on two previously unpublished works, the first by the Yemeni Sultan al Ashraf (ca. 1290) and the second by the astronomer Ibn Sim'un (ca. 1300) of Cairo. This lengthy article includes a brief introduction of the history of the magnetic compass in Europe and China and mentions previously known early Islamic sources on the instrument and its use. This is followed by some remarks on the authors and the manuscripts, the Arabic texts with English translations, and comments on problems the author encountered while working on the texts.[3714]

[3709] P. Duhem: Renaissance physics: in *Toward Modern Science* (Palter ed); op cit; pp 115-31; at p. 126. (This article is reprinted from 'Physics, History of, *Catholic Encyclopaedia,* XII (1911), pp 52-56.)
[3710] Ibid; p.126
[3711] Al-Biruni, *India*, (Engl. trans) Vol. II, pp. 103 and 105 in H.M. Said and A.Z. Khan: *AL-Biruni, His Times, Life and Works* (Hamdard Academy, Pakistan, 1981), at p. 127.
[3712] H.J.J. Winter: The Arabic achievement in physics, in *Toward Modern Science*; op cit, p 177.
[3713] Such as E Wiedemann: Zur Geschichte des Kompasses bei den Arabern. in, *Gesammelte Schriften,* vol. 1, pp. 226–35.
See also: E. Wiedemann; F. Hauser: Uber die Uhren im Bereich der islamischen Kultur. *Nova Acta, Abhandlungen der Kaiserl. Leop.-Carol. Deutschen Akademie der Naturforscher* 100:5 (1915): 1–272.
[3714] P.G. Schmidl: Two Early Arabic Sources on the Magnetic Compass; *Journal of Arabic and Islamic Studies*, Vol 1 (1996-7), pp. 80-156.

On light and sound, Al-Biruni concluded that the speed of light was immensely greater than that of sound, whilst works on music by al-Kindi include notions for the determination of pitch.[3715] Ibn Sina, who studied motion, contact, force, vacuum, and heat also studied light and musical theory. He suggested amongst others that light was capable of being measured, whilst on music he studied the physics of musical tones and of harmony.[3716] He dealt with doubling with the octave and doubling with the fourth and fifth, decisive steps towards the harmonic system.[3717] Among secondary sources dealing with this particular subject, nothing matches Farmer's countless works completed during the first half of the 20th century, examining the subject from every single perspective.[3718]

Abu Bakr al-Razi, centuries prior to Newton, made distinction between absolute and relative space; absolute space, which is three dimensional and infinite, exists quite independently of the bodies contained in it.[3719] On this Pines comments:

> 'Al-Razi appears to suggest as a proof for the existence of three dimensional space the fact that if one removes by means of the estimative faculty, or more probably the imagination (*al-wahm*), (all existing) bodies, absolute space will still remain in existence, i,e. it will still be imagined by that faculty (*wahm*).[3720] Elsewhere he adduces as a proof for the existence of empty space outside the world the fact that simple folk, whose soul has not lost its spontaneity, state that their reason tells them that such a space exists. In other words, Al Razi considers that the fact that a physical conception or representation is accepted as certain 1) by reason, or 2) by the estimative faculty or the imagination, is a proof of its real existence.'[3721]

[3715] G.Sarton: *Introduction;* vol 1; op cit; p. 546.
[3716] R.H. Major: *A History of Medicine*; op cit; p. 243.
[3717] Carra de Vaux: Astronomy; op cit; p. 391.
[3718] Citing at random: H.G. Farmer:
-The song captions in the *Kitab al-Aghani al-Kabir* (Trans Glasgow University; 1953-4).
-The Influence of al-Farabi's *Ihsa al-Ulum* on the writers on music in Western Europe; Journal of the Royal Asiatic Society; 561-92 (1932).
-Ghosts: An Excersus on Arabic Musical Bibliographies; in *ISIS*, 36; pp. 123-30;
[3719] Al-Razi also postulates the existence of Absolute Time, which is a 'flowing substance.' Unlike Aristoelian time its existence is not dependent on that of motion. It would continue to exist even if the world were to be annihilated; in S. Pines: Studies in Arabic; op cit; p.368:
[3720] P. Kraus: *Abu bakr Rhagensis (Razis) Opera Philosophica* (Cairo, 1939), p. 306.
[3721] In S. Pines: *Studies;* op cit; p. 368.

Ibn Baja's (Avempace) physics has been explored by Moody, as a result of Moody's enquiry whether Galileo's Pisan dynamics had any medieval origin.[3722] This led him to the translation of Ibn Rushd's commentary on Aristotle's *Physics*, where he came across Ibn Baja, who was a predecessor of Ibn Rushd. Ibn Baja was criticised by Ibn Rushd, but, when the Christian scholastics, Moody points out, commenced to study Aristotle's *Physics* and write their commentaries about it, they became aware of Ibn Baja's criticism of his law of motion, and had to weigh such criticism with that of Ibn Rushd.[3723] It was the positions which these two (Ibn Rushd and Ibn Baja) defended, which had, according to Moody, consequences of a scientific order, for they involved the fundamental issue of whether motion at uniform velocity, *against no resistance*, is the effect and measure of a force, or whether it is to be defined and measured by the rate at which *work* is done in changing the kinetic condition of a material body.[3724]

It is the practice among Muslim scholars that diverse sciences are associated for determining, or ascertaining results in practice and theory. In this instance, mechanics, for instance, is used to demonstrate the validity of mechanical theories; for example the law of inverse proportions can be demonstrated by showing that the ratio of two weights in equilibrium on a lever is inversely proportional to the ratio of their distance from the fulcrum.[3725] Al-Biruni even used the balance to demonstrate the rules of *Jabr and of muqabala*, and conversely, al-Khazini used the laws of proportion to determine the accuracy of balances.[3726]

The most decisive contribution of Muslim physics is again in the field of experimentation, a matter which demarcates Islamic science from its predecessors'.[3727] Greek physics reasoned and deduced but hardly ever calculated, says Benoit; calculation, he adds, being the essential foundation not only of the sciences but also of technology and economic activity.[3728] Hill also views that Aristotle speculative physics, and reverence to him had 'a stultifying effect upon creative thought.[3729] In

[3722] E.A. Moody: Galileo and Avempace: The dynamics of the leaning tower experiment in E.A. Moody edt: *Studies in Medieval Philosophy, Science and Logic* (University of California Press; London, 1975), pp 203-286.
[3723] Ibid; p. 235.
[3724] Ibid; p. 235 and fwd.
[3725] R. Arnaldez-L. Massignon: Arabic Science; op cit; p. 411.
[3726] Ibid.
[3727] R. Briffault: *The Making of Humanity*, op cit; p.191.
[3728] P. Benoit: Algebra, Commerce and calculation in *A History of Scientific Thought*; M. Serres editor; (Blackwell, 1995), pp 246-279; at p.246.
[3729] D.R. Hill: *Islamic Science*, op cit p 58.

contrast the experimental path taken by Islamic scientists constituted not just a breakthrough of considerable implication for physical investigations, but also freed scientific thought.[3730] Amongst Islamic experimenters in the subject were Al-Biruni and Al-Khazini, whose experimental skills were obvious in determining specific weights.[3731] In order to determine the specific weight of a specimen, its weight has to be known in air and water, and the volume of air and water displaced by the specimen. For this, Al-Biruni used a 'conical vessel,' and weighted meticulously the substance he wanted to study, then dipped it into his conical instrument that was filled with water. He weighed the water, which had been displaced by the immersed substance and which was escaping the instrument through a hole conveniently placed. The ratio between the weight of the body and that of the same water volume gave the specific weight sought.[3732] Al-Biruni summarised his findings in a number of tables, which show how extremely close he was to modern data (some of the deviations to be explained by the impurity of the specimen and by temperature differences in his experiments).[3733] His figures for the specific gravities of gold (19.05), mercury (13.74), copper (8.83), iron (7.74), tin (7.15) and lead (11.29) are very close to modern values.[3734] Al-Biruni also determined the specific weight of some liquids, and established the differences in the specific weights of hot and cold water and fresh and salt water. Most of all, he was the first to introduce control tests in the practice of experiments.[3735]

Finally it is worth citing some secondary sources for the study of Muslim physics. First is Pines, especially in relation to the originality of Islamic science in the field.[3736] There is a good, albeit short summary by Winter;[3737] as well as Jaouiche's translation (into French) and added comments of Thabit Ibn Qurra's *Kitab al-Qarastun*.[3738] Rozhanskaya (in

[3730] Ibid.
[3731] A. Mieli: *La Science Arabe; op cit;* p. 101. Mieli considers the determination of specific weights by al-Biruni and al-Khazini as outstanding manifestations in experimental physics
[3732] D.R. Hill: *Islamic*; op cit; p.58.
[3733] M. Rozhanskaya (with I.S. Levinova) Statics, in *The Encyclopaedia* (Rashed ed) pp 614-42. pp. 638-9.
[3734] Editorial: Islam and Science: Retrospect and Prospect; *Endeavour*; vol 4 (January 1945), pp. 1-2; and 34; at p. 2.
[3735] M. Rozhanskya: Statics; op cit; p.639.
[3736] See also S. Pines: What was original in Arabic Science, in *Scientific Change* A.C. Crombie ed (New York; 1963).
[3737] H.J.J. Winter: The Arabic achievement in Physics, in *Endeavour*, IX, 34 (1950), pp 76-9. Reprinted in A. Palter: *Toward Modern Science*, op cit, pp 171-8.
[3738] K. Jaouiche: *Le Livre du Qarastun de Thabit Ibn Qurra* (Leiden, Brill, 1976).

collaboration with I.S. Levinova,) gave a good outline on statics.[3739] Hill also made a valuable contribution to the subject.[3740] There are also excellent entries in the *Dictionary of Scientific Biography* on al-Khazini and Thabit Ibn Qurra.[3741] The best contributions to the subject remain the much older ones (late 19th-early 20th century) such as Khanikoff's translation of al-Khazini's work on the balance,[3742] and, above all, Wiedemann's (1852-1928) writings.[3743] These, complemented with primary sources, can build a better understanding of Muslim physics.

In this section chapter, the focus is on the Islamic atomic theory, and Al-Khazini's Balance of Wisdom.

2. A Word on the Atomic Theory:

In the early centuries of Islam, a movement arose aiming to solve problems of creation and religion. This movement, *Kalam*, literally conversation, was intended to be a rational explanation of religion, and included a thoroughgoing elaboration of the structure of matter and its relation to the Creator.[3744] The ideas of the *Mutakallimun*, the expositors of the *kalam*, assumed the task of explaining the theory of motion, space and time, and how they are concerned with matter, its construction, and its various characteristics.[3745] All this elaboration was necessary to clarify the ultimate concepts of the creation and the working of Allah.[3746] Many Muslim jurists objected to such theology. Ibn Hanbal (780-855), a famous jurist of Baghdad, for instance, disapproved of all theology on the ground that it

[3739] M. Rozhanskaya (with I.S. Levinova) Statics, in *The Encyclopaedia* (Rashed ed) pp 614-42.
[3740] D.R. Hill: Chapter four: Physics, in *Islamic Science;* op cit; pp 58-70.
[3741] R.E. Hall: Al-Khazini: *Dictionary of Scientific Biography*; op cit; vol 7; pp. 335-58; B.A. Rosenfeld and A.T. Grigorian: Thabit ibn Qurra; op cit; vol 13; pp. 288-95.
[3742] Al-Khazini: *Kitab Mizan al-Hikma*, Hyderabad; partial English translation by N. Khanikoff (1859).
[3743] For the best outline on Wiedemann's works, see H.J. Seemann: Eilhard Wiedemann; *ISIS*, 14; pp. 164-86.
See, for instance, E. Wiedemann: *Aufsatze zur Arabischen Wissenschafts-Geschichte,* 2 vols (Verlag, Hildesheim-New York, 1970).
[3744] S.M. Afnan: *Avicenna, his Life and Works* (London; 1958), p. 17.
[3745] M. Levey: *Early Arabic Pharmacology*; op cit; pp. 40-1.
[3746] Ibid.

was bound to go beyond the Qur'an by interpreting it according to human ideas, thus distorting its message, which was perfectly expressed in the Book of God.[3747] Theology was idle speculation that had not been practiced by Mohammed and his early companions, the models for later Muslims to follow.

The Mutakallimun's theories do, indeed, intrude into the world of theology and religious interpretation, and, directly and indirectly, raise issues, in which this author has no interest, for the Qur'an and Suna of the Prophet are, indeed, enough for religious guidance and practice. Thus, only points relevant to physics will be discussed here.

Pines reminds us how, for the *Mutakallimun*, not only bodies, but also time, space and motion, and all the qualities and properties pertaining to the atoms (for instance their colours) have an atomistic structure.[3748] In other words, everything is discontinuous. All atoms or quanta belonging to one particular category are similar; with no difference, for instance, between the quanta of motion from which every movement may be synthesized.[3749] A 12th century account of the ideas of the *Mutakallimun* on atomic theory is given by Maimonides,[3750] in 12 sections,[3751] and of which the following are extracts, as they are listed in Levey:[3752]

1. Every corporeal substance is made up of very small parts called atoms. These atoms are alike; they have no quantitative properties or relationship but may, at different times, possess qualitative values. When atoms come together, they are unified, combined, or compounded, or they are separated by some type of dissolution. In other words, there are four 'being' states-being unified or brought together, being separated, being in motion, and being at rest. God continually re-creating this infinite number of atoms.
2. Between atoms, there is a vacuum type separation. This vacuum allows for combination and separation. Atoms may come in contact with one another but cannot interpenetrate.

[3747] G.F. Hourani: Philosophy and Theology (Muslim); in *Dictionary of Middle Ages*; op cit; vol 9; pp. 567-72; at p. 568.
[3748] S. Pines: *Studies in Arabic Versions of Greek texts and in Mediaeval Science* (The Magnes Press, Brill, Leiden, 1986), p.355.
[3749] Ibid.
[3750] *More Nebuchin*; written in the early part of the 12th century, it was translated from the Arabic into Hebrew at an early date. Edited by S. Munk: *Guide des egares* (Paris; 1856), On time and recreation, see D.B. Macdonald, in *ISIS*, 9; pp. 320 ff.
[3751] S. Munk: *Guide des egares*; op cit; vol 1; p. 375 ff.
[3752] M. Levey: *Early Arabic Pharmacology*; op cit; pp. 41-2.

3. Time consists of atomic time elements or intervals not infinitely divisible, just as space and motion eventually come to the end of their divisibility. The paradoxes of Zeno are thus avoided by eliminating infinitesimals.
6. Matter is inseparable from accidents which, themselves, cannot endure two atoms of time. Thus, Allah continually recreates the accidents. This idea agrees with the observation that everything is in motion or at rest, or changes constantly in some fashion. Some scholars, however, contended that some atoms and accidents were created for a length of time and so did not necessitate continual recreation. There is no nature in any thing except by the will of Allah-only an accident by his consent or will.
11. There is no infinity of space, time, or extension, since the universe was created at the beginning and so had a Beginner.
12.The senses err and so cannot prove a case against a rational demonstration. Thus motion is in leaps but appears continuous. Matter appears continuous but is in discrete particles. Recreation is at every moment but appears as one continuous impression. The senses create illusions, since time must be in atoms according to pure reason.[3753]

The relation of the atom to matter in regard to the corporality of Allah and His creation was taken up seriously by the early *Mutakallimun*.[3754] The depth of their ideas may be detected in the wide range of their thinking as briefly noted here through the views of Abu Rashid al-Nishaburi (932-1068)[3755] who was the author of a treatise on the study of atomic substance.[3756] In this book he attempted to explain simultaneous existence and non-existence, divisions of atoms, their origin, the coexistence of two bodies in the same place and time.[3757] He assumed that the atom had dimensions and, therefore, that two atoms as a minimum would constitute a body.[3758] As for the form of the atom, Abu Rashid believed that it is in the form of a parallelopiped or cube so that other atoms may attach themselves every easily to the first.[3759] The sphere was therefore ruled out. Mass (a variable with regard to size according to the Greek Democritus) is a

[3753] D.B. MacDonald; ISIS; 9; pp. 329-37; in M. Levey: *Early Arabic Pharmacology*; p. 43.
[3754] F. Dieterici: *Der Musterstaat von Alfarabi* (Leiden; 1900), pp. 34 ff.
[3755] W. Alhwardt: *Verseichniss der arabischeen Handschriften der Kng.Bibiothek zu Berlin;* vol IV; p. 448.
[3756] *Kitab al-masail fi'l khilaf bain al-Basriyin wa'l Baghdadiyin; Al-Kalam fi'l Jawahir;* Ms. Berlin; 5225.
[3757] M. Levey: *Early Arabic Pharmacology;* op cit; p. 46.
[3758] A. Biram: *Kitabu'l masai'l* etc.. ed (Berlin, 1902).
See also M. Levey: Studies in the Development of Atomic Theory; *Chymia*; Vol 7 (1961); pp 40-56. p. 44.
[3759] M. Levey: *Early Arabic Pharmacology;* op cit; p 47.

constant like size, for it is a 'single property' as is existence.[3760] Furthermore all atoms are alike.[3761] He, Abu Rashid, discussed the problem of the possibility of one atom taking the place of two atoms.[3762] He also stated that two atoms may be separated without the presence of a third one between them. Empty space is thus postulated.[3763] Abu Rashid also declared that the atom must have a dimension.[3764]

The atomic theory occupied the minds of many other Muslim scholars, on whom it is needless to dwell too long here, but for more details, there are works by Lasswitz,[3765] Pines,[3766] and Levey.[3767] Beginning with Al-Ashari (b. 873-4-d.935-6) who coined various terms for the atom, usually indicating the original or primordial indivisible substance.[3768] Muslim authors believed that the minimum number of atoms in a body was four, six or eight.[3769] Al-Razi, in his book *Secret of Secrets*, contended that there were five types of atoms, which were indivisible and separated by a vacuum.[3770] Density determined the characteristics of softness, hardness, lightness, etc., of the four major elements: earth, air, water and fire. The space between the atoms determined the motion of the elements, whether they would rise as air and fire, or descend as water and earth.[3771] Abu al-Hudhail taught that a body was that which possessed a right and a left, front and rear, and top and bottom. A body must, therefore, consist of at least six parts or atoms.[3772] Some Muslims thought, as did Abu Bishr al-Salihi, that only two atoms could come together, others believed that two atoms formed a plane and three a solid.[3773] If one were to concede, according to al-Salihi, that one atom could touch a larger surface, then the entire world could be placed in a very small volume.[3774] Ibn Sina and Al-Ghazali, for their part, debated some matters of great interest, such as

[3760] Ibid.
[3761] Ibid.
[3762] A. Biram: *Kitabu'l masai'l*. op cit; p. 36.
[3763] Ibid. pp. 36-43.
[3764] Ibid. p. 47.
[3765] K. Lasswitz *Geschichte der Atomistik im Mittelalter bis Newton* (Leipzig, 1890, re-edited in 1926).
[3766] S. Pines: *Beitrage zur islamischen Atomlehre* (Berlin, 1936).
[3767] M. Levey: Studies (in *Chimya*, vol 7); op cit.
[3768] M. Levey: *Early Arabic Pharmacology*; op cit; p 43.
[3769] Ibn al-Murtada: *Al-bahr al-ssakhhar*; fol. 27 a-b; in M. Horten: *Die Phil. Systems der Spek. Theologen im Islam* (Bonn; 1912) p. 221.
[3770] J. Ruska: *Al-Razi's Buch Geheimniss der Geheimnisse* (Berlin; 1937).
[3771] G. Heym; in *Ambix*; I; p. 188; in M. Levey: *Early Arabic Pharmacology*; op cit; p. 45.
[3772] In M. Levey: *Early Arabic;* p. 45.
[3773] Ibid.
[3774] Ibid.

'How in a line of atoms can an atom remain indivisible when it is in contact on either side with two different atoms? Can movement, heat, and light be conceived in terms of atoms?'[3775]

All in all, as Levey concludes, not only were the Muslims transmitters of early Greek atomic theory, but they also contributed many original ideas on the nature of the atom, its association with other atoms, and matter in relation to the atom, and numerous elaborated theories on what occurs in the mixing and solution process.[3776]
Medieval writers of the Christian West inherited many such theories from their Muslim predecessors. Included amongst these were Occam, Nicolaus of Austria (14th century), Nicholaus of Cusa (15th century), Agrippa of Nettesheim (16th century), and others who preceded the exposition of the atomic theory as we now know it.[3777]

3. Al-Khazini's Balance of Wisdom:

Al-Khazini (fl. 1115-1130) lived and worked under the patronage of the Seljuk court.[3778] He was an ascetic character, handing back 1000 Dinars sent to him by the wife of an Emir, living instead on 3 dinars a year, sharing his house with a cat.[3779] Apart from the Balance of Wisdom, which will receive focus in this outline, another treatise of his is on instruments (*Risalat fi'l-alat*), found by Sayili in codices 682 and 681 of the library of the Sipahsalar Mosque in Tehran. It includes 17 folios in the manuscript.[3780] The treatise has seven parts, each devoted to a different instrument: a triquetrum; a dioptra; a triangular instrument; a quadrant; devices involving reflection; an astrolabe; and simple helps for the naked eye. Apart from describing the devices and their use, the treatise also demonstrates their geometrical basis.
Al-Khazini like Al-Quhi and Ibn al-Haytham before him, sought to unify the two concepts of gravity in relation to the centre of the universe, and in

[3775] Carra de Vaux: Astronomy and Mathematics, op cit; p. 391.
[3776] In M. Levey: *Early Arabic*; p. 51.
[3777] J.R. Partington: Annals of Science; 4; p. 245. R. Hooykaas: The Experimental Origin of chemical atomic and molecular theory before Boyle; in *Chymia* 2; pp. 65-80.
[3778] R.E. Hall: Al-Khazini; *Dictionary of Scientific Biography*, op cit; 335-6.
[3779] Ibid.
[3780] A. Sayili: Al-Khazini's treatise in R.E. Hall: Al-Khazini, p. 338.

relation to an axis of suspension of a lever.[3781] Al-Khazini was first to make the proposition, that:

> 'For each heavy body of a known weight positioned at a certain distance from the centre of the universe, its gravity depends on the remoteness from the centre of the universe. For that reason, the gravities of bodies relate according to their distances from the centre of the universe.'[3782]

This proposition was adopted only six centuries later in Europe, in the 18th century following developments in the theory of gravitation.[3783]

As a student of statics and hydrostatics, Al-Khazini borrowed immensely from al-Biruni and al-Asfizari.[3784] Using the same instrument as al-Biruni, he made repeated trials with several metals and gemstones. He also measured the specific gravities of other substances: salt, amber, clay etc, noting whether the substance sank or floated on water. The accuracy of such measures is evident, showing hardly any deviations from modern values.[3785] In the process, Al-Khazini was also able to show that both water at the freezing point and hot water were of lower density than water at an intermediate temperature.[3786] He also observed that the buoyancy of the air must affect the value of the weight of an object weighed in it.[3787]
The bulk of Al-Khazini's findings are summed up in his treatise *Kitab Mizan al-Hikma* (The Balance of Wisdom).

Al-Khazini's *Kitab Mizan al-Hikma* was written in 1121-1122 for the Seljuk Sultan Sanjar's treasury, and has survived in four manuscripts, of which three are independent.[3788] It was partly translated and edited by the Russian envoy Khanikoff in the mid 19th century.[3789] Though the work deals principally, and in great detail, with the practice of accurate weighing and the determination of specific gravities, it also discusses

[3781] In A. Djebbar: *Une Histoire*, op cit, p 248-9.
[3782] *Kitab Mizan al-Hikma*, English translation, p.24. in M. Rozhanskaya: Statics, op cit, pp 621-2.
[3783] A. Djebbar: *Une Histoire*; p. 249.
[3784] R.E. Hall: Al-Khazini, in *Dictionary of Scientific Biography*, op cit.
[3785] D.R. Hill: *Islamic*, op cit, p. 66.
[3786] Editorial: Islam and science; (*Endeavour*, vol 4) op cit; p. 2.
[3787] Ibid.
[3788] Al-Khazini (N.Khanikoff ed.) p.16. In R.E. Hall: Al-Khazini; op cit; p. 341.
[3789] Al-Khazini: *Kitab Mizan al-Hikma*, Hyderabad; partial English translation by N. Khanikoff (1859); 'Analysis and extracts of *Kitab mizan al-Hikma* (book of balance of Wisdom), *Journal of the American Oriental Society* vol 6: pp. 1-128; also Russian translation by M.M. Rozhanskaya and I.S. Levinova 'Al-Khazini. Kniga vesov mudrosti,' *Nauchnoye nasledstvo*, Moscow, vol 6, (1983); pp 15-140. See also R.E. Hall: Al-Khazini; op cit.

gravitation, flotation, and geodesy.[3790] It studies the hydrostatic balance, its construction and uses and the theories of statics and hydrostatics that lie behind it and other topics, altogether eight subjects:

1.Theories of centres of gravity according to various Greek and Muslim scholars.
2. Further discussion on centres of gravity, mechanism of the steelyard.
3. Comparative densities of metals and precious stones, according to al-Biruni.
4. Balance designed by some Greek and Muslim scholars.
5.The water balance of Umar al-Khayam, its adjustment, testing and use.
6.The comprehensive balance; determination of the constituents of alloys.
7. Weights of coinage.
8. The Steelyard clepsydra.

The eight books are very informative.[3791] First, by looking at his predecessors' science, al-Khazini provides crucial records of their contributions that could have remained unknown or lost. In dealing with their theories of centres of gravity, Al-Khazini most particularly draws attention to the Greeks' failure to differentiate clearly between force, mass and weight, and shows awareness of the weight of the air, and of its decrease in density with altitude.[3792] In Book Three, for instance, Al-Khazini brings to knowledge Al-Biruni's measurements of weights, instruments and procedures, which would otherwise have been lost. Interestingly, the treatise also includes other matters, little to do with the balance, such as the rising and sinking of mountains.[3793]

Most of Al-Khazini's treatise, however, deals with hydrostatics, most particularly the determination of specific gravities. Al-Khazini goes to great length in describing the equipment necessary to obtain accurate results. 'The balance of wisdom,' he says:

> 'Is something worked out by human intellect, and perfected by examination and trial... Among its advantages:
> 1) Accuracy in weighing, this balance showing variations to the extent of a mithqal...
> 2) It distinguishes pure metal from its counterfeit, each being recognised by itself, without any refining;
> 3) That it leads to a knowledge of the constituents of a metallic body composed of any two metals, without separation of one from

[3790] H.J. Winter: Mechanics and mechanical appliances; in *ENDEAVOUR,* vol 15; (January 1956) pp. 25-8; at p. 27.
[3791] For an excellent outline of these, see R.E. Hall: Al-Khazini; op cit; pp 341-2.
[3792] D.R. Hill: *Islamic Science*, op cit, p. 61.
[3793] R.E. Hall: Al-Khazini; op cit; p. 342.

> the other, either by melting, or refining, or change of form, and that in the shortest time and with the least trouble....'[3794]

Al-Khazini uses this balance for varied purposes, from ordinary weighing, to taking specific gravities, examining the composition of alloys, changing dirhems to dinars, and many other operations.[3795] Al-Khazini's scrupulousness in the preparation of his equipment and materials, and in carrying out varied applications of his balance, make his work one of the best examples 'of rigorous attention to scientific accuracy,' Hill observes.[3796] His balance could perform the most accurate measurements, of up to 1 in 60,000.[3797] Expressed in other terms, the balance was accurate to 0.06 gm on a load of 2.2 kg.[3798] Such accuracy owes to the length of the beam, the special method of suspension, the extreme closeness of the centre of gravity and the axis of oscillation, and of course to the minutely precise construction of the instrument.[3799] Expressed in modern terms, and compared with modern values, some of al-Khazini's results show remarkable accuracy:

Substance	Specific gravities (Al-Khazini)	Modern Value
Gold:	19.05 (cast)	19.26-19.3
Mercury:	13.56	13.56
Lead:	11.32	11.39-11.445
Silver:	10.30	10.43-10.47
Copper:	8.66 (cast)	8.67-8.73
Brass:	8.57	8.45-8.60
Iron:	7.74 (forged)	7.60-7.79
Tin:	7.32	7.29
Emerald:	2.75	2.68-2.77
Pitch:	1.04 (white)	1.07
Sweet Water:	1.00	1.00
Boiling Water:	0.958	0.960
Olive Oil:	0.920	0.918-0.919
Blood of a man in		

[3794] From N. Khanikoff: ''Analysis and extracts; op cit; pp. 8-14.
[3795] D.R. Hill: *Islamic Science*, op cit, p 69.
[3796] Ibid; p 70.
[3797] Excellent drawings of such an instrument can be found in both The Encyclopaedia (Rashed ed) (at p. 636) and the Dictionary of Scientific Biography (R.E. Hall's Al-Khazini's entry), at p: 346.
[3798] Editorial: Islam and science; (*Endeavour,* vol 4) op cit; p. 2.
[3799] D.R. Hill: *Islamic Science*, op cit, p 70.

Good health:	1.033	1.053[3800]

This tabulation of specific gravities, Hill points out, was conceived much earlier by the Muslims than by the Europeans. Serious attention was first paid to the subject in Europe during the 17th century, culminating in the work of Robert Boyle (d. 1691).[3801] He determined the specific gravity of mercury, for instance, by two different methods, giving values of 13.76 and 13.357.[3802] Both of these are less exact than the value recorded by al-Khazini, most of whose results, as can be seen, were fairly accurate.[3803]

Al-Khazini's work went beyond mere measurements, and as Winter points out, it captures the comprehensive nature of Muslim study of the balance. The following quotations say much about this:

> 'This just balance is founded upon geometrical demonstrations, and deduced from physical causes, in two points of view:
> 1. It implies centres of gravity, which constitute the most elevated and noble departments of the exact sciences, namely, the knowledge that the weights of heavy bodies vary according to difference of distance from a point in common-the foundation of the steelyard.
> 2. As it implies a knowledge that the weights of heavy bodies vary according to difference in rarity or density of the liquids in which the body weighed is immersed-the foundation of the balance of wisdom.
> To these two principles the ancients (the Greeks) directed attention in a vague way, after their manner, which was to bring out things abstruse, and to declare dark things, in relation to the great philosophies and the precious sciences. We have, therefore, seen fit to bring together, on this subject, whatever useful suggestions their works and the works of later philosophers, have afforded us, in connection with those discoveries which our own meditation, with the help of God and His aid, has yielded.'[3804]

And:

> 'Novelties and elegant contrivances in the way of balances, such as: the balance for weighing dirhems and dinars without resort to counterpoises; the balance for levelling the earth to the plane of the horizon; the balance known as the even balance', which

[3800] Ibid; p. 66.
[3801] Ibid.
[3802] Ibid.
[3803] Ibid.
[3804] N. Khanikoff: Analysis; op cit; p. 10.

> weighs from a grain to a thousand dirhems or dinars by means of three pomegranate counterpoises; and the hour balance, which makes known the passing hours, whether of the night or the day, and their fractions in minutes and seconds, and the exact correspondence therewith of the ascendant star, in degrees and fractions to a degree.'[3805]

Hour balances consisted essentially of a long lever, one arm of which carried a vessel of water emptying in twenty four hours. The other arm had a sliding weight acting as a counterpoise and moving over the calibrations on the arm.[3806] It was usual to calibrate the right hand arm by silver encased at appropriate distances along it, and the divisions were in units corresponding to the particular functions of the balance, such as units of time, values of specific gravities, etc.[3807] The Muslims, as Winter also points out, were thoroughly familiar with the application in surveying and building of the parallelism of a balance beam with the plane of the horizon when the beam is evenly loaded.[3808]

4. Optics:

Ibn al-Haytham (965-1039) is generally thought to be the only Islamic contributor to optics with his *Kitab al-manazir* (Book on Optics). In the more erudite works on the subject, such as by Lindberg, one finds other Muslim scientists involved in the subject.[3809] Rashed, too, has made extensive studies with respect to some authors such as al-Farisi.[3810] Djebbar makes a brief list of other authors and their works:
-Al-Kindi (801-873): *Risala fi ikhtilaf al-manazir* (Treatise on Divergences in Optics).
Risala fi islah kitab Uqlidis (Book on the Corrections of the Optics of Euclid.

[3805] H.J. Winter: Mechanics; op cit; p. 27.
[3806] Ibid.
[3807] Ibid.
[3808] Ibid.
[3809] D.C. Lindberg: *Studies in the History of Medieval Optics* (London, variorum; 1983). D.C. Lindberg, *Theories of Vision from Al Kindi to Kepler* (Chicago and London, 1976). *-A Catalogue of Medieval and Renaissance Optical Manuscripts* (Toronto; 1975).
[3810] I.e R. Rashed: Le Model de la Sphere transparente et l'explication de l'arc en ciel: Ibn al-Haytham, al-Farisi; in *Revue d'Histoire des Sciences*; Vol 23: pp 109-40.

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[3810] Le R. Rashed: Le Modèl de la Sphere transparente et l'explication de l'arc en ciel: Ibn al-Haytham, al-Farisi; in *Revue d'Histoire des Sciences*; Vol 23; pp 109-40.

-Ibn Isa (10th c): *Kitab fi l-hala wa qaws quzah* (Book on the Halo and the Rainbow).
-Ibn Mansur (10th c): *Kitab al-Manazir* (Book on Optics)
-Al-Farisi (13th c): *Tanqih al-manazir* (Revision of the Book of Optics).
-Ibn Ma'ruf (16th): *Kitab nur hadaqat al-absar* (Book on the Light of Accuity…)[3811]

The following outline is unable to go into these works and will focus instead on pre-Islamic optics and on Ibn al-Haytham.

Pre-Islamic (Greek) Theories of Vision:

Optics remained for about thirteen centuries the battlefield of the Greeks and their followers, the symbol of cogitation and speculation triumphant over experimentation. The Greeks were roughly divided into two diametrically opposed camps around the issue of vision; those who stood by the 'intromission' theory, something entering the eyes representative of the object, and those who stood by 'emission,' vision occurring when rays emanate from the eyes and are intercepted by visual objects.[3812]
Within each half of the argument, there were more divisions. Omar explains that among intromission theorists, opinion varied considerably, for example around the manner in which the image is transmitted to the eye, the nature of the medium, and so on.[3813] The difficulty in coming to a cohesive, precise conclusion on optics resided with the multiplicity of the arguments, and the fact that proponents of different arguments were inconsistent on many accounts.[3814]

Without getting bogged down in the complexities of the Greek arguments, here is a brief outline of the issue of vision as it stood before the Muslims.[3815]

[3811] A. Djebbar: *Une Histoire*, op cit; p. 268.
[3812] D.R. Hill: *Islamic Science*, op cit, p 70.
[3813] S.B. Omar: *Ibn al-Haytham's Optics*: Bibliotheca Islamica (Chicago, 1977), p.17 fwd.
[3814] See G.A. Russell: Emergence of Physiological optics, in the *Encyclopaedia* (Rashed ed) op cit, pp 672-715; pp 673-85 in particular.
[3815] D.C. Lindberg: Introduction in *Optica Thesaurus: Alhazen and Witelo*; editor: H. Woolf. Johnson (Reprint Corporation, New York, London, 1972).
D.R. Hill: *Islamic Science*, op cit, pp 70-1.
S.B. Omar: *Ibn al-Haytham's Optics;* op cit; p. 17 fwd.

Basically, as Omar explains, there were two diametrically opposed Greek theories of vision. The first, the intromission theory (Aristotle, Galen and followers), explained vision in terms of the entry into the eye of 'something' representative of the object. Opposed to this was the emission theory (Euclid and Ptolemy and followers,) which held that vision occurs when rays emanate from the eye and are intercepted by visual objects.[3816]
Almost without exception, the Greek intromission theorists were physicists, and so adopted a physical approach to the problem of vision. Before Aristotle, Greek Atomists sought to apply philosophical views, explaining vision in terms of 'a coherent form, a thin film of atoms encompassing the object, which leaves the object and enters the eye.'[3817] Aristotle's theory itself is largely based on general observations, interpreted according to his own philosophical system. The relation between the eye and the object is not made clearer by Aristotle's denial of emission from the object. On the halo and the rainbow, he even adopts a theory, which is contrary to his own.[3818] The fact is that, while the intromission theory, and its various versions, seems physically more sound than the emission theory, it lacks the ability to explain the manifold phenomena presented by vision.[3819]
The emission theory (Euclid and his followers,) maintains that a ray issues from the eye and proceeds to the object of vision where its termination constitutes the act of vision. The idea of radiation from the eye relies (due to its author (Euclid) on geometrical explanations for vision. It fails to take account of physical, physiological and psychological elements that affect vision. Ptolemy sought to harmonise the geometric with physical approach. He even carried out some experiments in support of his views. The problem, as raised by both Omar and Hill, was that his experimentation was to support his already preconceived theory, even manipulating experiments for that purpose,[3820] which is the exact opposite of what experimentation is supposed to achieve.
Both intromission and emission theories, thus, suffer from exactly what Greek science suffers from: its reliance on cogitation and the lack of experimental foundation.

In explaining the passage from Greek to Islamic optics, Lindberg, very ingeniously, subdivides Greek optical theories into five main strands:

[3816] S.B. Omar: *Ibn al-Haytham's Optics*, op cit; p. 17.
[3817] Ibid; p. 18.
[3818] Ibid; p 19.
[3819] Ibid; p.20.
[3820] D.R. Hill: *Islamic Science*, op cit, p 71.

1) Aristotle's description of light as the actualisation of the potential transparency of a medium by imposition of a form on the medium and his intromission theory of vision.
2) Neoplatonic views on the emanation of power.
3) The opinion of Galen and others on the anatomy of the eye and the physiology of sight.
4) The intromission theory of the atomists.
5) The geometrical tradition originated by Euclid and Ptolemy.
It should be noted, Lindberg adds, that all of these strands, except perhaps the second, are principally concerned with one very fundamental question: How do we see? consequently, they involve questions of a physiological and psychological sort as well as of physics and mathematics.[3821]

Islamic Optics:

The solution to Greek optics came in stages as is well explained by Lindberg.[3822] Early Islamic followers of Galen held the view that vision occurred through a ray, which issued from the eye towards the object, and either by touching the object or compressing the intermediate air conveyed an impression of the object on the eye.[3823] Hunayn ibn Ishaq (d.877) somehow sides with Galen. In his *Ten Treatises and Book of the Questions on the Eye*, he makes a more systematic version of Galen's theory, and provides a more advanced ocular anatomy. Al-Kindi, on the other hand, attacks the intromission theory because of its incompatibility with the laws of perspective.[3824] Al-Kindi does not fail to make a critique of Euclid either, but fails to formulate the ultimate theory of optics.[3825] Still his work, preserved in Latin translation, was to have great influence on Roger Bacon and other Western men of science.[3826] More doubts about Greek theories of vision arose with Al-Razi in his lengthy treatise *Kitab fil'l Kaffiyat al-Ibsar…*, which, from its title (Book on Properties of Sight Where it is Proved that Sight Does not Occur by Means of Rays Issuing From the Eye and the Propositions of Euclid's Work on Optics are Refuted,) clearly reasserts the refutation of both Euclid and Ptolemy on

[3821] D.C. Lindberg: Introduction in *Optica* op cit; p. xiv.
[3822] D.C. Lindberg, *Theories of Vision from Al Kindi;* op cit.
[3823] A.I. Sabra: The Scientific experience; op cit; pp. 188-9.
[3824] D.C. Lindberg: The Science of optics, in *Science in the Middle Ages*, edited by D.C. Lindberg, op cit, pp 338-68, p. 344.
[3825] M. Meyerhof: Science, op cit, p. 320.
[3826] Ibid.

visual sights, and puts forward the foundation for the doctrine that sight occurs by means of light rays issuing from a source of light.[3827]

It was Ibn al-Haytham, who contributed most to the resolution of the problem of vision, and set up the foundations for modern optics. Ibn al-Haytham, according to Sabra, saw that a correct theory of vision had to combine the 'mathematical' approach of Euclid and Ptolemy with the 'physical' doctrine favoured by the natural philosophers.[3828] Lindberg notes how the five strands, cited above, converge in Ibn al-Haytham.[3829] From neo-Platonism through Al-Kindi, Ibn al-Haytham gained his concept of a power propagated from all natural bodies, and in the case of light this power consists of forms imposed on the medium by the presence of a visible body. Galen's views on the anatomy of the eye and his identification of the crystalline lens as the sensitive organ are reproduced with little change by Ibn al-Haytham, whose intromission theory of sight also owes something to both the Atomists and the Aristotleians, whilst his geometrical optics follows Euclid and Ptolemy.[3830] However, Lindberg points out, Ibn al-Haytham's optical system is by no means simply a composite of these earlier traditions, he took the ancient materials at his disposal and constructed out of them a new edifice.[3831]

Ibn al–Haytham's most influential work is *Kitab al-Manazir*, translated into Latin as *De aspectibus* or *perspectiva* (The Book of Optics) by Gerard of Cremona in the 12th century is lost in the original; but the first three books (on direct vision) were edited in 1983,[3832] and translated into English (London 1989) by Sabra. The basic element of the *Perspectiva*, of course, is its theory of direct vision; it may thus be of value to describe this theory in general terms as Lindberg does.[3833] The medieval Latin version begins with an attack on the ancient theory of visual rays. The emission theory (Euclid and followers), maintained that a ray issues from the eye and proceeds to the object of vision where its termination constitutes the act of vision. To Ibn al-Haytham it contradicts a number of fundamental observations, such as that an observer looking at a bright light may have the sensation of pain, and an afterimage remains when he

[3827] B. Rosenfeld and E. Ihsanoglu: *Mathematicians*, op cit; p. 66.
[3828] A.I. Sabra: The Scientific Experience; op cit; p. 188.
[3829] D.C. Lindberg: Introduction in *Optica*; op cit; p. xiv.
[3830] Ibid.
[3831] Ibid.
[3832] Ibn Al-Haytham: *Kitab al-Manazir*; books I-III (on direct vision) edited by A.I. Sabra (Kuwait; 1983).
[3833] D.C. Lindberg: Introduction; op cit; p. xv.

shifts his gaze to a darker place. These and other observations imply that the eye is the recipient of an action coming from without, which may occasion pain and injury if sufficiently strong, and which leaves its impress in the eye after the eye turns away.[3834] He, thus, concludes that:

> 'Light issues in all directions opposite any body that is illuminated with any light [and of course, also opposite any self luminous body]. Therefore when the eye is opposite a visible object and the object is illuminated with light of any sort, light comes to the surface of the eye from the light of the visible object.'[3835]

Ibn al-Haytham equally resolves the problems of the intromission theory by explaining physical contact between the object and observer through the intromitted rays, and through its visual cone explained the perception of shape (which had been ignored by Aristotle) and accounted for the laws of perspective. Ibn al-Haytham incorporates in his theory the mathematical achievements of Euclidean visual cone, and the anatomical and physiological tradition of Galen.[3836]

Ibn al-Haytham's greatest merit is in his reliance on experimentation. As Hill notes, he rejects the axiomatic approach of his predecessors, whereby postulates are assumed to be self evident, and any experiments just meant to reinforce axioms.[3837] Equally, Ronan points out how Ibn al-Haytham breaks with the Greeks, his work citing no authority 'but the authority of empirical evidence.'[3838] In this, Ibn al-Haytham is not particularly innovative, but simply pursuing his Muslim predecessors' path. Al-Kindi, who flourished more than a century before Ibn al-Haytham, who came from the same part of southern Iraq as him, and who also wrote consistently on optics, surely had a great impact on him in this respect. Al-Kindi, in relation to the Greek deficiency in experimenting, in the second optical treatise on burning mirrors or rays, recalls Anthemius' report on how ships were set aflame by burning mirrors during a naval battle:

> 'Anthemius should not have accepted information without proof... He tells how to construct a mirror from which twenty four rays are reflected on a single point, without showing how to establish where the rays unite at a given distance from the middle of the mirror's surface. We, on the other hand, have described this

[3834] Ibid.
[3835] Ibid.
[3836] D.C. Lindberg: The Science of Optics; op cit; pp. 347-9.
[3837] D.R. Hill: *Islamic Science*, op cit, p 72.
[3838] C.A. Ronan: The Arabian, op cit, p. 228.

> with as much evidence as our ability permits, furnishing what was missing, for he has not mentioned a definite distance.'[3839]

Following on the same path as his Muslim predecessors, Ibn al-Haytham is concerned principally with the origin of the first principles and their justification, the first step in any scientific investigation, and even more, he is very much aware of the fallibility of sense-perception.[3840] Omar also comments how Ibn al-Haytham recognises that:

> 'It is part of 'human nature' to employ the senses, fallible as they are, as 'the tools' for studying nature. Thus man, lacking any other alternative short of scepticism, if he is to study nature through the senses, can only conduct it by perfecting these tools 'to the maximum degree that this is possible.'[3841]

It was Ibn al-Haytham's consistent and constant attempt to perfect those 'tools', Omar adds, which, more than any other single factor, was responsible for this 11th century physicist's development 'of the experimental method to unprecedented levels of sophistication, and its deployment in roles foreign to those of the 'experiments' of his predecessors.'[3842]

Omar goes on to reproduce some of Ibn al-Haytham's experiments, including drawings and figures.[3843]

The other merit of Ibn al-Haytham, according to Russell, is his capacity to resolve complex issues into independent yet closely interrelated simple investigations, subjecting every problem to a quantitative analysis of its variables under strictly controlled conditions.[3844]

Lindberg comments that it is not possible to generalise on the results or the display of wealth of geometrical techniques employed in Ibn al-Haytham's *Perspectiva*, which was far superior to earlier optical works, and no optical treatise composed before the 17th century rivalled it mathematically.[3845] His *Kitab al-manazir* impacted upon Roger Bacon (13th century), Witelo, da Vinci and Kepler.[3846] His studies of the refraction of light and his laws of refraction were relied upon by both

[3839] *Kitab al-Kindi fi al-shua'at*; in J. Jolivet and R. Rashed: Al-Kindi; *Dictionary of Scientific Biography*; op cit; vol 15; pp. 261-6; at p. 264.
[3840] D.R. Hill: *Islamic Science*, op cit, p 72.
[3841] S.B. Omar: *Ibn al-Haytham's Optics*; op cit; p. 55.
[3842] Ibid.
[3843] Ibid.
[3844] G.A. Russell: Emergence, op cit, at p 686.
[3845] D.C. Lindberg: Introduction; Optica; op cit; p. xix.
[3846] M. Meyerhof: Science, op cit, 334.

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[3843] Ibid.
[3844] G.A. Russell: Emergence, op cit, at p 686.
[3845] D.C. Lindberg: Introduction; Optica; op cit; p. xiii.
[3846] M. Meyerhof: Science, op cit, 334.

Kepler and Descartes.[3847] Kepler, in fact, took up where Ibn al-Haytham left off.[3848]

Ibn al-Haytham's 'revolutionary' breakthroughs are, however, far from being revolutionary. It is important to note with Rashed,[3849] that when historians analyse Ibn Al-Haytham's dioptrics, for instance, they refer only to Ptolemy, which gives the impression that Ibn al-Haytham was preceded by 'a vacuum reaching back to Ptolemy[3850] and followed by another vacuum up to al-Farisi.'[3851] In truth, Ibn al-Haytham relied to great extent on other Muslim writers on the subject who flourished just prior to him, and one amongst such writers was Ibn Sahl (fl. 984 at the court of Baghdad.) In his *Discourse on Light* Ibn al-Haytham referred explicitly to Ibn Sahl and recalled some of the latter's ideas on the transparency of media and refraction.[3852] Ibn al-Haytham also copied Ibn Sahl's opuscule entitled: *Proof that the Celestial Sphere is not Completely Transparent.*[3853] Rashed also points out that Ibn Sahl was the first to have studied lenses.[3854] When Ibn Sahl had completed his examination of burning mirrors, both parabolic and ellipsoidal, Rashed notes, he considered hyperbolic plano convex lenses and the hyperbolic biconvex lenses, and also stated what is called Snellius' law centuries before the latter.[3855] Ibn Sahl's contribution to optics was, thus, quite substantial, and not just in terms of the subjects he addressed, but also coming just a few decades before Ibn al-Haytham, from the same land of Iraq (Ibn al-Haytham came from Basra). The closeness of the two scholars in space and time was bound to induce in Ibn al-Haytham's mind a powerful spirit of research on a similar topic, and also armed him with scientific facts, which served him decisively.

[3847] C.A. Ronan: The Arabian, op cit, p 229.
[3848] D.C. Lindberg: The Western reception of Arabic optics, in the *Encyclopaedia* (Rashed ed), op cit, pp 716-29, at p. 727.
[3849] R. Rashed: A Pioneer in Anaclastics: Ibn Sahl on Burning Mirrors and Lenses; *ISIS*; vol 81; 1990; pp. 464-91; at p. 465.
[3850] Although Al-Kindi and Hunayn Ibn Ishaq are often mentioned. See, for instance, D.C. Lindberg: *Theories of Vision from al-Kindi;* op cit.
[3851] R. Rashed: A Pioneer in Anaclastics; op cit; p. 465.
[3852] R. Rashed: Le Discours de la Lumiere d'Ibn al-Haytham: traduction Francaise critique; *Revue d'Histoire des Sciences* (1968), vol 21; pp. 197-224.
[3853] R. Rashed: *Geometrie et dioptrique au Xem siecle: Ibn Sahl al-Quhi et Ibn al-Haytham;* Collection Sciences et Philosophie Arabes; Textes et Etudes; Paris; Les Belles Lettres (forthcoming at the time when Rashed wrote article in *ISIS* referred to above).
[3854] R. Rashed: A Pioneer in Anaclastics; op cit; pp. 465-6.
[3855] Ibid; pp. 466.

Ibn al-Haytham other accomplishments, to a very large extent, were also built on his Muslim predecessors who studied the same subjects, and that can be found amongst others with Al-Kindi, for instance. His treatise *On the Burning Glass* exhibits a profound and accurate conception of the nature of focussing, magnifying, and inversion of the image, and of formation of rings and colours by experiments.[3856] In his treatise '*The Shape of the Eclypse,*' Ibn al Haytham makes an attempt to explain the crescent image cast by the partially eclipsed sun through a small round aperture.[3857] Ibn al-Haytham also wrote on the rainbow, the halo, and spherical and parabolic mirrors, and fixed the height of the atmosphere at the equivalent of about ten English miles.[3858] More of Ibn al-Haytham's accomplishments are explained by Schramm, but in German.[3859]

Lesser known than Ibn al-Haytham is a writer on optics of Mamluk Egypt: Al-Qarafi (d. 1285) who was a *faqih* (a scholar in law) of the Maliki persuasion, and who wrote mostly on theology. However, one scientific work of his is on optics: *Kitab al-Istibsar fima tudrikuhu'l absar* (The Revelation of What the Eyes May Perceive).[3860] In al-Qarafi's day, the majority of the problems related to optics were studied under the titles of optics and perspective; the optical phenomena appearing in the atmosphere were discussed in books on meteorology, other optical problems were studied in connection with astronomy. In al-Qarafi's work (Revelation etc), questions of all three kinds are studied in one book.[3861] Al-Qarafi's preparation of this book was initiated by the five questions sent by the Emperor of Sicily, Frederick II, to King al-Kamil.[3862] In the book mentioned, Al-Qarafi investigates fifty questions, two of these are said by him to be the Emperor's questions (Questions 25 and 30 in al-Qarafi's book).[3863] The first of these seeks the reason why Canopus appears larger when on the horizon, and Question 30 deals with the explanation of some kind of hallucination.[3864] Wiedemann dealt with al-

[3856] M. Meyerhof: Science; op cit; p. 334.
[3857] A.I. Sabra: The Scientific; op cit; p. 188.
[3858] M. Meyerhof: Science, op cit, p 335.
[3859] M. Schramm: *Ibn al-Haytham's Weg zur Physik* (Wiesbaden; 1963).
[3860] A.M. Sayili: Al-Qarafi and his explanation of the rainbow; *ISIS* XXXII; pp. 16-26, at p.16.
[3861] Ibid, p.26.
[3862] M. Amari: Questions philosophiques adressees aux savants musulmans par Frederick II; *Journal Asiatique*; (1853) I; p. 240-74.
[3863] For the nature of these questions, consult: E. Wiedemann: Optics Studien in Laienkreisen im 13. Jahrhunder in Aegypten, *Jahrbuch fur photographie und Reprodktionstechnik;* 27 (1913), p. 65 ff.
[3864] A.M. Sayili: Al-Qarafi and his explanation; op cit; p.17.

Qarafi's treatment of the problem of mirages,[3865] (which is the topic of his 37th and 38th problems) and his explanation of the rainbow.[3866] In Al-Qarafi's explanation of the colour of the rainbow, we read:

> 'In vapours the colour of the sun is always red, as the colour of the sunset sky and the colour seen after the morning twilight show us; because this red colour is composed of the (colour of the) light of the sun and that of the vapour; (it is not a body, therefore, that causes the red colour in the rainbow). The damp vapours are partly dense, namely the ones far from the earth which are stiffened into stones because the cold existing in these high regions; and (the damp vapours are) partly rare in the lower locations because they are far away from these cold regions and because the vapours ascending from the earth are heated through the effect of the heat in the earth. So the dense vapours appear almost black, very nearly sky blue (*asmanjuni*), the rare ones appear pure (clear) without blue. The colour next to the red is black. It is a rule, however, that if black and red mix together yellow is produced. There are, therefore, four colours on the rainbow: red, yellow, sky blue, and the pure colour. There are two (types) of colours, the colour of the vapours and that of the sun; and then the colour composed of these two.'[3867]

After al-Qarafi, the two other illustrious figures of Islamic optics were Qutb al-Din al-Shirazi,[3868] and Al-Farisi. The latter repeated and improved Ibn al-Haytham's experiments on the camera obscura (*al-Qamara or al-beit al-muzlim*), and also observed the path of the rays in the interior of a glass sphere, hoping to determine the refraction of solar light through raindrops. His findings enabled him to give an explanation of the formation of the primary and secondary rainbows.[3869]

[3865] E. Wiedemann: Uber fata Morgana nach arabischen Quellen, *Meteorol Zeitschrift,* 30 (1913), p. 246 ff.
[3866] E. Wiedemann: Arabische Studien ubr den Regenbogen; *Archiv fur die Gesch, der naturwissenschaftern und der Technik,* 4 (1913), p. 457 ff.
[3867] A.M. Sayili: Al-Qarafi and his explanation; op cit; p.19.
[3868] G. Sarton: *Introduction*, op cit, p. 23.
[3869] G. Anawati: Science, op cit, pp. 755-6.

Concluding Words on Islamic Sciences

The most suitable way to end this part on sciences is to quote the following observations by Al-Kindi, which highlight perfectly a dominant aspect of Islamic sciences. He realised that the mere reading of ancient texts-in Greek or Arabic-could become an obstacle to clear thought, unless it was used as a call to consult nature herself, and to solve the apparent contradictions in that way. Mere book-learning is inadequate and even pernicious; we must 'follow along the paths of nature' to understand her.

> 'When we do not know the principles, causes and reasons of things, we cannot understand them, and perhaps there is no man more ignorant in this respect than he who has delved into the writings of ancient scientists and considers them sufficient for obtaining the truth about scientific problems, without reviewing the sciences in their proper order...
> Accepting the wisdom of the ancients is futile unless their principles are first recognised and brought into harmony. It is vain to keep to the letter of their writings unless the letter is first understood and evaluated.'[3870]

[3870] Al-Kindi: *Epistles; (Rasail al-Kindi al-Falsafiya;)* I; p. 91; in R. Amaldez-L. Massignon: Arabic Science; op cit; pp. 383-4.

PART THREE

THE ISLAMIC DIMENSION

The study of celestial phenomena was necessary in Islam so as to determine accurately the times of the daily prayers throughout the year, and find the direction of Makkah (Mecca) from every geographical location where there are Muslims.[3871] This study was also necessary for finding the beginning and ending of the month of fasting by the exact definition of the new moon.[3872] Thus faith had a direct impact on the rise of modern astronomy, a subject that has been examined in great detail in the chapter on the subject in the previous part, just as it was done by King,[3873] and by Sayili.[3874] A similar relationship between faith and practical religious needs has also been seen in the preceding part in relation to other sciences (mathematics, engineering, farming, geography, etc). Other links between faith and learning and civilisation will be discussed further on, including how Islamic art was a direct result of the faith requirements that no living form ought to be reproduced, how the construction of baths was imposed by the need to purify oneself before prayers, and so on.

The Qur'an and the sayings of the Prophet, as will be examined further on, also had their crucial impact on the pursuit of knowledge, the Prophet, for instance, repeatedly calling on Muslims to seek knowledge. Islam's

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[3871] G. Anawati: Science; in *The Cambridge History of Islam;* in two vols; edited by P.M. Holt; A.K.S. Lambton; B. Lewis; vol 2 (Cambridge University Press; 1970), pp. 741-79; at p. 758.

[3872] Ibid.

[3873] D.A. King: *World Maps for Finding the Direction and Distance to Mecca* (Al-Furqan, London, and Brill; Leiden; 1999). It is an excellent illustration of the intricate association of astronomy, mapping and Islam, and how Islam stimulated mathematical astronomy in particular.

[3874] A. Sayili: *The Observatory;* op cit; pp. 20 ff.

principal institution, the mosque, as will also be amply examined, acted as a learning and even research institution.
The direct impact Islam had on the rise of Islamic civilisation is also obvious in their simultaneous rise (after the 7th century), and their simultaneous decline (in the 13th century, following the destruction of almost the whole Islamic state).

This relationship between the Islamic faith and the rise of science and civilisation, although clearly obvious, finds no place in the writing and teaching of nearly all Western historians, or that of non-Westerners with a Western educational background. Islam, instead, is seen and described as an obstacle, in fact the worst obstacle, and even an enemy, to science, civilisation and learning. Even some of the few Western historians who have some admiration for Islamic civilisation depict Islam as antagonistic to science and progress, and that it was Islam, the faith, which caused the decline and fall of Islamic civilisation. The so-called 'orthodoxy' (Sunni Islam), the Turks and other non Arab Muslims (Berbers), are deemed the worst agents in such decline.

This is the central issue which is examined in this part. In its first chapter, it looks at the argument for equating faith, in general, and Islam, most particularly, as hostile to science and progress. The second examines the supposed role of Islam in this collapse of Islamic civilisation. The third, and final chapter, concludes that if Islam is found not responsible for the decadence of Islamic society, as this work argues, what are the causes?

One

SOURCES OF THE PROBLEM

Why religion, Islam above all, is considered an obstacle to science and civilisation, even if in the case of Islam all historical evidence shows the very opposite, can be ascribed to three central elements that are focused upon in this first chapter:
-The traditional conflict between Western Christianity and science, a concept that has been extended to all other civilisations, including Islam.
-The traditional hostility to Islam.
-The need to maintain a disparaging perception of Islamic civilisation for ideological purposes.

1. The Western Christian Experience Generalised to All:

In Western Christendom, during the Middle Ages, the Catholic Church was able to dictate most domestic as well as foreign policies. On the foreign level, it was the Church which, for instance, launched the crusades, and which led in the efforts and policies to destroy Islamic trade.[3875] Domestically, the Church yielded immense spiritual power over the people. It inherited vast land estates, and grew extremely rich through the sale of relics. Also, those who died without bequeathing a part of their property to the Church, died without confession and the sacraments, and forfeited Christian burial.[3876] Self-interest was often a reason for

[3875] See for instance: W. Heyd: *Histoire*; Vol II; op cit.
[3876] J.W. Draper: *A History of the Intellectual Development of Europe*; op cit; p.377.

generosity towards the church, although, as Hay insists, it was mainly piety, which was the cause for endowment by the laity.[3877] During that same medieval period, the Church also dominated the intellectual and cultural life. Medieval education, music, art, and architecture were motivated by, permeated with, or channelled into religious goals, and the most highly regarded branch of learning, the 'Queen of the Sciences,' as it was called, was theology, the study of doctrines concerning God.[3878] Western education was almost the exclusive province of the clergy. As Devons outlines: Grosseteste's disciple: Roger Bacon was the Franciscan 'Dr Mirabilis' of Oxford and Paris, the renowned Albertus Magnus was 'Dr Universalis' of Cologne, Provincial of the German Dominican Order and Bishop of Ratisbon; Albertus' disciple, Witelo, was a Silesian Dominican at the Papal court at Viterbo; John of Peckham was Archbishop of Canterbury; Theodoric of Freiberg a Dominican leader of German preachers, etc.[3879] Understandably, the chief centres of culture, as Haskins notes, were the monasteries, islands in a sea of ignorance and barbarism saving learning from extinction in Western Europe at a time when no other forces worked strongly to that end.[3880] Popes also sponsored learning and manifestations of culture throughout the whole period, and even more crucially, the earliest revival of learning in Western Christendom is owed to Gerbert of Aurillac, subsequently Pope Silvester (999-1003).[3881] The translation effort of Muslim sciences of the 12th century was also primarily conducted under the patronage of religious figures, Raymond de Sauvetat, archbishop of Toledo (1126-1151), and his contemporary Michael, bishop of Tarazona.[3882]

The Church medieval history is dotted with dark episodes, though. Some such dark episodes and history relate primarily to the issue under consideration here: how the Western Church repressed intellectual freedom, and how it suppressed 'heretical' learning, and how this antagonism between Church and learning has been generalised to include

[3877] D. Hay: *The Medieval Centuries* (Methuen and co, London, 1964), pp. 45-7.
[3878] D J. Geanakoplos: *Medieval Western;* op cit; p..307
[3879] S. Devons: Optics through the eyes of the medieval Churchmen; in *Science and Technology in Medieval Society*: Edition Pamela O Long: *Annals of the New York Academy of Sciences*, vol 441 (New York, 1985), pp 205-24. at p. 206.
[3880] C.H. Haskins: *The Renaissance of theTwelfth Century* (Harvard University Press, 1927), pp. 32-4.
[3881] R. Allen: Gerbert Pope Sylvester II; *The English Historical Review*: Year 1892; pp 625-668.
[3882] J. Puig: Arabic philosophy in Christian Spain; in *The Introduction of Arabic Philosophy into Europe*; ed C.E. Butterworth and B.A. Kessel (Brill; Leiden; 1994), pp. 7-30; at p. 11.

all other civilisations, including the Islamic, where learning and science followed the rise of the faith. This makes it necessary to address some of such Church history. It is not, however, in the Muslim tradition to write or comment on the history of the Church or Christianity. This author is not going to break this tradition, and he neither disposes of the competence, nor the will, nor the interest to do so. Those who are interested in the dark history of the Church need to consult other sources, this being neither the focus of this work, nor of this author. Thus, out of sheer necessity to make the argument, this author will deal, as briefly as possible with some issues and instances, which relate to the specific matter under discussion here, i.e the antagonism of faith to learning, and then move on.

The Church's attitude to 'heresy' and its efforts to suppress it during the medieval period are illustrated here through some instances. In 1134 Peter de Brueys was burnt in Languedoc (France) for his denying infant baptism, the worship of the cross, and transubstantiation. Henry the Deacon, the disciple of Peter, had also been disposed of.[3883] The year 1210 saw the posthumous condemnation of two academic heretics, David of Dinant (fl second half of the century) and Amalric of Bena (d. 1206-7) both scholars; Amalric was a teacher of theology at Paris.[3884] In 1212 Bishop Henry of Strasbourg, in one day, burned eighty 'heretics' most of whom were Waldenses.[3885] In Champagne, the convicts to burn on one occasion were so numerous as to require pens made of stakes and filled with straw.[3886] Before the archbishop of Rheims and seventeen other prelates, one hundred and eighty three heretics, together with their pastor, were burnt alive.[3887] In England, the Oxford theologian, Ockham was cited to appear at the papal court on heresy charges, but without waiting for the verdict he and Michael of Cesena (head of the Franciscan Order, also accused) decided to flee to the German court of Louis IV.[3888] In the south of France, 'heresy' was suppressed by an army officered by French prelates; bishops, who were its generals, and an archdeacon who was its engineer; also present was the Abbot Arnold, the legate of the pope.[3889] There, in the south of France, such 'heretics', were burnt alive in the

[3883] J.W. Draper: *A History;* op cit; Vol II; p. 60.
[3884] M.L. Colish: *Medieval Foundations of the Western Intellectual Tradition 400-1400* (Yale University Press; 1997), p.246.
[3885] W. Durant: *The Age of Faith,* op cit; Chapter 28; p.784.
[3886] J.W. Draper: *A History;* op cit; Vol II; p.75.
[3887] Ibid.
[3888] M.L. Colish: *Medieval Foundations;* op cit; p.311.
[3889] J.W. Draper: *A History;* op cit; p. 62.

thousands.[3890] A century later, in the 14th century Victor le Clerc in his Discourse on the state of letters in France, says that, as the burning of forbidden books was not enough, it was decided, that in anticipation of the burning of hell-fire, it was necessary to burn authors and their disciples.[3891] Thus, in 1308 were burnt Dolcino of Navarre, who was preaching 'goodness to the community;' in 1315 the Cathars of Austria; in 1319, those of Marseilles; in 1325, in Girone; Durand de Valdac, Bourgeois of that town; in 1327, in Florence, the poet Cecco d'Ascoli, and in Ascoli itself, Dominique Savi, author of works and preaching that earned him ten thousand disciples.... 'Why have men of faith in power given the example of barbaric punishments, which bring shame on justice itself?' Asks Le Clerc'[3892]

It is needless to dwell on further misdeeds committed by, or in the name of, the Church, which went on well into the 17th century, and which have been examined in so many works.[3893]

At a time when learning in Islam was the fruit of independent minds, including considerable numbers of scholars from other faiths, elsewhere, as Draper notes:

> 'A Christian party asserted that all knowledge is to be found in the Scriptures and in the traditions of the Church; that, in the written revelation, God had not only given a criterion of truth, but had furnished us all that he intended us to know. The Scriptures, therefore, contain the sum, the end of all knowledge. The clergy, with the emperor at their back, would endure no intellectual competition....'[3894]

Hence, when Gerbert (Pope Sylvester II, 999-1003), after visiting Muslim Spain, took north of the Pyrenees the system of Arabic numerals, his

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[3890] See J. W. Draper: *History of the Conflict Between Religion and Sciences* (Henry King & co; London; 1875).

[3891] V le Clerc (1789-1865) in *Discours sur l'Etat des Lettres en France au XIV e siecle* (HL 24, 7-9, 1862).

[3892] Victor le Clerc In G. Sarton: *Introduction*; Volume III; op cit; pp. 22-4.

[3893] Such as:

-D.M. Traboulay: *Columbus and Las Casas*; op cit; preface; p.ix.

- H.C. Lea: *A History of the Inquisition in Spain;* 4 vols (The Mac Millan Company, New York, 1907).

-J.W. Draper: *A History; op cit.*

-D. E. Stannard: "Genocide in The Americas" in *The Nation*, (October 19, 1992 pp. 430-434).

-R. Garaudy: *Comment l'Homme devint Humain* (Editions J.A, 1978).

[3894] J. W. Draper: *History of the Conflict; o*p cit.

mathematics was deemed 'dangerous Saracen magic.'[3895] In the Christian West, Lacroix explains, from the time of Plotinus and Porphyrus (Greek Antiquity) to that of Cardan and Paracelsus (15th century 'Renaissance'), no man of eminence could assist the progress of science or make any great scientific discovery without being reputed a magician, or stigmatised as:

> 'A sorcerer-a fatal appellation which, attached to the name of a noble victim of his love for science, disturbed his repose, often interrupted his labours, and sometimes put his liberty and life in peril.'[3896]

Those who fell victim of that constituted basically the whole foundation of learned men of Western Christendom: Raymond Lull, Albert Magnus, Roger Bacon, Vincent of Beauvais, and many others, who, after having composed a great number of remarkable works could not escape suspicions and persecutions.[3897]

This image of an agency persecuting learning was compounded by a general impression of static demeanour, which little encouraged the innovative spirit. This is captured, for instance, in Daniel of Morley's dedication of his *Philosophia* to John of Oxford, Bishop of Norwich from 1175 to 1200:

> 'When, some time ago, I went away to study, I stopped a while in Paris. There, I saw asses rather than men occupying the chairs and pretending to be very important. They had desks in front of them heaving under the weight of two or three immovable tomes, painting Roman Law in golden letters. With leaden styluses in their hands they inserted asterisks and obeluses here and there with a grave and reverent air. But because they did not know anything, they were no better than marble statues: by their silence alone they wished to seem wise, and as soon as they tried to say anything, I found them completely unable to express a word. When I discovered things were like this, I did not want to get infected by similar petrification.... But when I heard that the doctrine of the Arabs, which is devoted entirely to the quadrivium, was all the fashion in Toledo in those days, I hurried there as quickly as I could... He (the reader) should not despise the simple and clear opinions of the Arabs, but should note that

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[3895] William of Malmesbury, History of the kings of England, trans. Revd John Sharpe (London, 1815), P. 199); in Louise Cochrane: *Adelard of Bath* (British Museum press, 1994), p. 43.

[3896] P. Lacroix: *Science and Literature in the Middle Ages* (Frederick Ungar Publishing Co, New York, 1964), p.204.

[3897] Ibid.

> Latin philosophers make heavy weather of these subjects quite unnecessarily, and, through their ignorance, have put figments of their imagination veiled in obscure language, so that their unsteady floundering in this subject might be covered by a blanket of unintelligibility.'[3898]

However, as Bucaille points out, the medieval period was 'a time of stagnation,' but science was not hampered by the Judeo Christian Revelation itself, but rather by those who claimed to be its servants.[3899] Expanding on this, Bucaille says:

> 'The relationship between religions and science has not always been the same in any one place or time. It is a fact that there is no writing belonging to a monotheistic religion that condemns science. In practice however, it must be admitted that scientists have had great difficulties with the religious authorities of certain creeds. For many centuries, in the Christian world, scientific development was opposed by the authorities in question, on their own initiative and without reference to the authentic Scriptures. We already know the measures taken against those who sought to enlarge science, measures which often made scientists go into exile to avoid being burnt at the stake, unless they recanted, changed their attitude and begged for pardon. The case of Galileo is always cited in this context: he was tried for having resumed the discoveries made by Copernicus on the rotation of the earth. Galileo was condemned as the result of a mistaken interpretation of the Bible, since not a single Scripture could reasonably be brought against him.'[3900]

When, eventually, the power of the Church began to lessen, in the late 16th and the 17th century in particular, this order of persecution became reversed.[3901] Then began the process which we have today: the learned elite persecuting religion, so to say. Following the 'Renaissance,' Bucaille explains, the scientists' natural reaction was to 'take vengeance on their former enemies.'[3902] This conflict rose in intensity in the wake of the Darwinian theory of evolution, Freudian science, and other 20th century

[3898] Daniel of Morley, Philosophia, ed. G. Maurach, pp 204-55; In C. Burnett: *The Introduction of Arabic learning into England;* The Panizzi Lectures, 1996 (The British Library, London, 1997), pp 61-2.
[3899] M. Bucaille: *The Bible, the Quran, and Science*, translated from French by A.D. Panell and the author; 7th ed (Seghers; Paris; 1993), pp 125-6.
[3900] Ibid.
[3901] D. Gerhard: *Old Europe* (Academic Press; New York; 1981), p. 104.
[3902] M. Bucaille: *The Bible, the Qur'an,* op cit. p. 126.

manifestations. Today, science and religion, if they meet in the Western realm, do so only in the terrain of conflict: anyone talking of God in scientific circles 'does stand out.'[3903] Kung even notes how when asked whether he believed in the existence of God, a Nobel laureate answered: 'Of course not, I am a scientist.'[3904]

Today, equating faith with hostility to science does not just apply to the Western experience, but is generalised to all faiths. The principal reason owes to the fact that the science that rules the world today is Western, the very science that arose primarily in conflict with the faith. Because Western science is modern world science, its experience is generalised to all. Which is, fundamentally a gross misreading of history. The Muslim experience (7th-13th centuries) is, indeed, wholly different from the Western. Derry and Williams note how:

> 'Islam, unlike medieval Catholicism, did nothing to stifle the spirit of scientific enquiry.. and so, from Basra to Cordova, great universities arose centuries before the earliest *studium generale* in Christendom, with their huge libraries, and a Muslim craftmanship on a par with its scholarship.'[3905]

And as Kettani holds:

> 'Claiming that all religious experiences are the same and projecting the Western experience to the Muslim world results from a serious ignorance of historical realities.'[3906]

Sadar explains that the apparent conflict of science and religion, and their separation in 'watertight compartments, is:

> 'A uniquely Western creation, the result of hostilities between those who claimed to be custodians of Christianity and those who challenged their power. What institutionalised Christianity did to intellectuals and scientists of the Middle ages is well recorded in European history. But to take an inductive leap from what was a particularly European experience and generalise it to an all embracing conflict between science and religion is not just Eurocentric but also poor scholarship. Such historic experiences

[3903] Ibid.
[3904] H. Kung: Does God exist? New York: Doubleday, 1980; pp xxiii, quoted in Wan Mohd Nor wan Daud: *The Concept of Knowledge in Islam* (Mansell, London and New York, 1989), p. 22.
[3905] T.K Derry and T.I Williams: *A Short History of Technology* (Oxford at the Clarendon Press, 1960), pp. 28-9.
[3906] A Kettani: 'Science and Technology in Islam, The underlying value System,' in Z. Sardar ed: *The Touch of Midas; Science, Values and Environment in Islam and the West* (Manchester University Press, 1984), pp 66-90; at p. 66

are alien to non European civilisations such as those of China and Islam. For their world views reason and revelation, science and religion, are two sides of the same coin.'[3907]

Muslim science rose, indeed, as a response to the demands of the faith. This has amply been shown in the preceding chapters, and just as Millas Vallicrosa notes, the impulse to worship prompted the Muslim scholar to look more closely into 'the marvels that the Lord has set before our eyes.'[3908] One such scholar, Al-Battani, as an instance, in the beginning of his *Zij al-Sabi,* says:

'The science of stellar bodies is of immense utility because it makes possible the knowledge of the length of the year, the months, and different times and seasons; the lengthening and shortening of day and night, the positions of the sun and the moon as well as their eclipses, and the courses of the planets in their direct and their retrograde motions, the alterations of their forms, and the arrangement of their spheres. This, he asserts, leads people, who reflect deeply and persistently, to the proof of the unity of God and the comprehension of His majesty, to His immense wisdom, infinite power, and to a grasp of the excellence of His work.'[3909]

Equally, Al-Urdi holds that:

'The usefulness of astronomy is immense to those 'who contemplate on stellar marvels and the motions of the heavenly bodies, and that to the reflecting mind there are in these matters remarkable circumstances and solid proofs concerning God's existence.'

'Astronomy,' [he adds,] 'leading to the science of theology and giving evidence 'of God's magnificence.'[3910]

Heinen also observes how Al-Khazini published in the *Kitab Mizan al-Hikma* a remarkable memorandum on science being rooted in an all-encompassing justice.[3911] Millas Vallicrosa further comments that Muslim writers introduced their works on astronomy, botany and the various

[3907] M. H Sadar: Science and Islam: is there a conflict? in *The Touch of Midas;* pp 15-25; p.15.
[3908] J.M. Millas Vallicrosa: Arab and Hebrew Contributions to Spanish Culture; in *Cahiers d'Histoire Mondiale*; vol 6; 1960; pp. 732-51, at pp. 736.
[3909] Al-Battani in A. Sayili: *The Observatory in Islam*; op cit; p. 15.
[3910] Muayyad al-Din al-Urdi: *Kitab al-Hay'a*, ms., Konya, Yusuf Aga Library, No 6829, p. 1b, in A. Sayili, *The Observatory in Islam*; op cit, p. 17.
[3911] A. M. Heinen: Religion and Science in Islam; in *Encyclopaedia of the History of Science*, (Editor: H. Selin;) op cit; pp 861-4: p. 864.

natural sciences imbued by warm religious fervour, and overflowing thankfulness to 'the Creator, making it clear that it was this sense of worshipping admiration, induced by the miraculous works of the Lord, that sustained them to toil while others slept,' and they thank the Lord for permitting them to achieve their aim.[3912]

This intimate link between Islam, the faith, and learning remains either ignored, or rejected, or both. Bucaille, thus, remarks:

'The association between the Qur'an and science is *a priori* a surprise, especially since it is going to be one of harmony and not of discord. A confrontation between a religious book and the secular ideas proclaimed by science is perhaps, in the eyes of many people today, something of a paradox. The majority of today's scientists, with a small number of exceptions of course, are indeed bound up in materialist theories, and have only indifference or contempt for religious questions which they often consider to be founded on legend. In the West, moreover, when science and religion are discussed, people are quite willing to mention Judaism and Christianity among the religions referred to, but they hardly ever think of Islam. So many false judgements based on inaccurate ideas have indeed been made about it, that today it is very difficult to form an exact notion of the reality of Islam.'[3913]

All this leads one to ask, why are there such false judgements and misconceptions about Islam?
The answer is found in a long tradition of false depictions and hostility to Islam; so old, so engrained, so much part of established culture, that its Western apologists have found neither ability, nor will, to deviate from it.

2. Enduring Antagonism to, and Misrepresentations of, Islam:

Hostile depictions by Muslims of the Church and Christians surely exist. However, no Muslim has ever slandered the Christian faith or Jesus. Islam does not have either a whole network of academics whose task is to study,

[3912] J.M. Millas Vallicrosa: Arab and Hebrew Contributions; op cit; at pp. 736-7.
[3913] M. Bucaille: *The Bible, The Quran;* op cit; p.121.

write, distort, and advise political agencies in the spread of discord and conflict in the ranks of the foe. Nor in Islam does an academic-media-intellectual elite exist, whose task is to rant daily about the deficiencies of Western society, Western crimes past and present, and so on and so forth. Written and verbal onslaughts on Islam, the Prophet, Muslims, Islamic society, on the other hand, have been a constant reality in Western culture for centuries to this day, such that it has become the most systematic rant in history, as will be briefly outlined here. Also outlined is the fact that this onslaught on Islam is derived from, or based fundamentally on distortions. Hence, what we see is a culture of onslaught based on lies, enduring for centuries, and prevailing to this very day.

In the Middle Ages:

According to Christian tradition, the Muslims practice polytheism, and worship statues and representations of the Prophet (PBUH).[3914] In William's epics,[3915] the Muslims, other than being hideous, treacherous, cowardly, arrogant, and willing to sacrifice their first-born sons, adore the gods: Mahomet, Cahu, Appolyon, and Tervagant, which are all earthly idols.[3916] Fulk of Chartres who took part in the first crusade and lived in Jerusalem for over a quarter of a century tells that in the Dome of the Rock the Muslims 'used to pray to an idol made in the name of Mahumet.'[3917] Pagans and Muslims were one and the same in the *Ars Fidei Catholicoe* of Alanus de Insulis (b.ca 1128), where he has a section '*contra paganos seu Mohometanos*',[3918] whilst Jacques de Vitry wrote: 'as often as the followers of Mohammed possess the Temple of Solomon, they set up his statue in the Temple and permit no Christian to enter.'[3919]

[3914] C. Pellat, 'L'idée de Dieu chez les «Sarrasins» des chansons de geste', *Studia islamica*, 22, (1965), 5-24.
[3915] *Guillaume d'Orange; Four Twelfth Century Epics;* Tr John Ferrante (New York; 1974), pp. 63-139.
[3916] In Jo Ann Hoeppner Moran Cruz: Popular Attitudes Towards Islam in Medieval Europe; in *Western Views of Islam in Medieval and Early Modern Europe;* Ed by D.R. Blanks, and M. Frassetto (St. Martin's Press; New York; 1999), pp. 55-82; at p. 58.
[3917] Fulcheri Carnotensis…in B. Z. Kedar: *Crusade and Mission* (Princeton University Press; 1984), at p. 89.
[3918] J.W. Sweetman: *Islam and Christian Theology* (Lutterworth Press; London; 1955), Vol I; Part II. P. 66.
[3919] D.C. Munro: The Western attitude toward Islam during the period of the Crusades; *Speculum* Vol 6 No 4, pp. 329-43; pp 331-2..

The Prophet is also said to have made himself adored as an idol, and even as a god, the *Gesta Francorum* speaking of gods, and of oaths taken by Muhammad as a god.[3920] For Sigebert of Gembloux (d.1112), 'this is the Muhammad to whom the Gentiles, hitherto offer the worship of a deity.'[3921]

For the Medieval English historian, Mathew Paris:

> 'A sort of infernal lightning, which, however, descended from the skies, had suddenly set fire to and destroyed the temple of Mahomet, together with his statue; and that again a second explosion similar to the first, had reduced the said temple to small bits; and that a third had, as we believed, thrust the ruins into an abyss in the earth. After this, he said, this fire, which burned with a most devouring heat, though it did not give a bright light, crept along under the earth, like the fire of hell, consuming even rocks in its way, and could not even yet be extinguished. And thus the whole city of Mecca, and the country in its vicinity, were consumed with inextinguishable fire.'[3922]

Tancred (a crusade leader) was heard in 1099 to have found a silver idol of the Prophet in the Temple of 'the Lord,' a fable which was the result of a misunderstanding and mistranslation of the chronicler Fulcher of Chartres, but as Munro points out, taken up by today's scholars.[3923] When the Byzantine emperor, Manuel I Comnenus (1143-80), sought to show that it is inaccurate to equate Islam with idolatry he became embroiled in controversy with the ecclesiastical hierarchy.[3924] Even prominent figures, such as the Bolognese professor of civil law Azo (1150-1230) wrote a commentary on the Code of Justinian that tells that 'the pagans, that is the Saracens, worship innumerable gods, goddesses, and indeed demons.'[3925] All these depictions conflict with truth knowing that Islam's first deed is to destroy idols.

Muslims, just like their faith, suffer similar hostile depictions. Epics associated with Aymeri of Narbonne and his son, William of Orange, (written ca 1200, but legendary from the previous century), treat the

[3920] In D.C. Munro: The Western attitude; op cit at p.331-2.
[3921] Sigebert of Gembloux, quoted in B.Z. Kedar: *Crusade*; op cit; p. 86.
[3922] Mathew Paris' English History, vol III, p.231 in J. Dahmus: *Seven Medieval Historians* (Nelson-Hall, Chicago, 1982), p.172.
[3923] D.C. Munro: The Western: Op cit; pp 331-2.
[3924] G.L. Hanson: Manuel I Comnenus and the 'God of Muhammad' A Study in Byzantine Ecclesiastical politics; in J. V. Tolan. Ed: *Medieval Christian Perceptions of Islam* (Routledge; London; 1996), pp. 55-84.
[3925] Azo: Summa Aurea, to Cod.1.11; Lyons; 1557; col 7a; in B. Z. Kedar: *Crusade and Mission*; op cit; p. 88.

Muslims as idol worshipers, and portray them as wicked creatures.[3926] They, the Muslims, are the authors of every evil, hating God and actively seeking Satan; they eat their prisoners, betray their oaths, and sell their own womenfolk.[3927] According to the Dominican Missionary, Riccoldo da Montecroce, who went to Baghdad in 1291, Muslims were confused, mendacious, irrational, violent, and obscure.[3928] Marco Polo in his Travels (1298)[3929] is very tolerant of the Mongols, even full of admiration for them and for Hulagu who had destroyed the Caliphate, and is also full of praise for the idolaters, primarily Buddhists and Hindus.[3930] As for the Muslims, he details with pleasure the overthrow of the Caliph in 1258 in Baghdad by Hulagu, and he describes Muslims as treacherous, prone to great sinfulness, and 'as dogs not fit to lord it over Christians.'[3931] As to their faith, it is the: 'accursed doctrine of the Saracens [is that] every sin is accounted a lawful act even to the killing of every man who is not of their creed.'[3932]

Muslims are also deemed sexually perverse. From *Le Couronnement de Louis,* we read that people were attracted to Islam by the pleasures of drinking and sexual gratification.[3933] Guilbert (of Nogent) (d. ca 1124-30), thus describes the Muslims:

> '. . .The more they abandoned themselves in all ways, as if authorized by heaven itself, to all kinds of excess in these permitted vices, the more they covered up the wickedness of it, in praising the grace of God, who accorded, in his indulgence, these loose times. All the severity of Christianity was condemned and given over to public insults; the teachings of honesty and virtue which had been laid down by the Evangels were accused of being hard, of being cruel; and on the contrary those that the cow had brought were called the teachings of generosity and were recognized as the only ones in accord with the liberty instituted by God himself. … But since they did not place any restraint on the indulgence of the senses, one soon saw them giving themselves

[3926] *Aymeri de Narbonne, Chanson de Geste*; ed. Louis Demaison (Paris; 1887), 2 vols.
[3927] In Jo Ann Hoeppner Moran Cruz: Popular Attitudes; op cit; pp. 56-7.
[3928] In Z. Sardar; M-W. Davies: *Distorted Imagination* (Grey Seal Books; London, 1990), p 38.
[3929] *The Travels of Marco Polo;* Trans R. Latham (New York; 1958).
[3930] In Jo Ann Hoeppner Moran Cruz: Popular Attitudes Towards Islam; op cit; p. 67.
[3931] Ibid.
[3932] Ibid; p. 68.
[3933] E. Langlois: *Le Couronnement de Louis*; 2nd rev; Paris; 1966; in Jo Ann Hoeppner Moran Cruz: Popular Attitudes Towards Islam; op cit; p. 58.

> up to vices that even the ignorant animals ignore entirely and that are not even decent to mention…'[3934]

Sodomy is widely associated with Muslims,[3935] and the associated vision of the Muslim is that of a figure of extremes-excessive in zeal, in cruelty, and in sensuality, a picture enduring for centuries.[3936] Ademar of Chabannes, a French Monk of the late 10th-early 11th century (989-1034), describes the Muslims:

> 'Burning with concupiscence and without modesty, men lie with men, women with women… and people copulate with animals.'[3937]

Daniel points out how Western Christendom uses these identifications to explain Islam's great appeal, an appeal which is due to nothing else:

> 'Than to its corruption of souls, offering people sensuous pleasures Christianity would never contemplate to even address.' Christianity since its early days,' [Daniel remarks,] 'had stressed the value of total sexual continence in a way that was foreign to Islam.'[3938]

Islam, of course, was viewed as a heresy. The Eastern Christian, John of Damascus, wrote that there arose among the Arabs a man named Mamed, who became acquainted with the Old and New Testaments, and later, after discoursing with an Arian monk, 'established his own sect', which he imagined to be a new religion.[3939] Another version on how the Prophet acquired his teaching is by Gauthier de Compiègne (12th century,) who says that Mohammed was a poor child, but was raised by a baron who made his fortune in Persia, India and Ethiopia, and whose trust Mohammed wins, before a Christian hermit teaches him about the Old and New Testaments.[3940] In *L'Entrée d'Espagne*, a later poem, the Prophet (PBUH) is described as a former Christian leader frustrated at being denied the Papacy,[3941] hence driving him to start a new religion. Before

[3934] D.C. Munro: Western; op cit; p.334.
[3935] N. Daniel: *The Cultural Barrier* (Edinburgh University Press, 1975), p.166.
[3936] John Sweetman: *The Oriental Obsession* (Cambridge University Press, 1987), p.6.
[3937] G. Duby: The Knight, the Lady and the Priest; Trans B. Bray; Chicago; 1983; pp. 57-120; in. M. Frassetto: The Image of the Saracen as Heretic in the Sermons of Ademar of Chabannes; in *Western Views of Islam* (Blanks-Frassetto ed); op cit; pp. 83-96; at p. 89.
[3938] N. Daniel: *The Arabs and Medieval Europe*; op cit; p.230.
[3939] John of Damascus: *De Haeresibus*, *Patrologia Graeca*, vol. 94, 761-71; in G. Von Grunebaum: *Medieval Islam* (The Chicago University Press; 1969), p. 43.
[3940] Gauthier de Compiègne. *Otia Machometi. In* E. Edelstand du Méril, *Poesies populaires latines du moyen âge* (Paris, 1977).
[3941] *L'entrée d'Espagne, Chanson de Geste Franco-Italienne*; ed. A. Thomas; 2 vols (Paris; 1913), I, cii, II, 2444-64.

then, it was a monk who became a cardinal named Nicolas, who to take revenge on his attackers, makes of the Prophet the instrument of his revenge. Then Nicolas becomes the Prophet himself, hence Mohammed was initially in Rome, celebrated and adulated, but because angry for not having been elected pope, founds a new rival religion.[3942] Sir John Mandeville, a 14th century traveller to the Muslim land, explains Mohammed's Prophecy as follows:

> 'You ought to know that Muhammad was born in Arabia, and at first was a poor fellow, looking after horses and camels and travelling with merchants of Egypt, which at that time was inhabited by Christians. In the desert of Arabia, on the highroad to Egypt, there was a chapel, and a hermit living in it. And Muhammad went into the chapel to speak to the hermit. And when he entered the chapel, the doorway, which was very low, suddenly grew as tall as the gate of a great palace. This as they say, was the first miracle he did, when he was young. After that Muhammad began to be wise, and rich, and a great astronomer. The prince of the land of Corodan (Khorasan) made him ruler and governor of his land; and he governed it wisely and graciously, so that, when the prince was dead, he married the princess, who was called Cadrige (Khadija).'[3943]

The Prophet, according to d'Alverny becomes the agent of 'Perverse Jews,' and also heretic Christians: Nestorians, Jacobites, Arians, etc, depending on who makes the attack on Islam.[3944]

Tolan explains how associating Islam with paganism justified the crusades as a vengeance against 'such pagans.'[3945] Thus, during the first crusade (1095-), according to the Christian apologist Tudebodus, the crucifix, confronted with an idol of Machomet, began to bleed miraculously.[3946] Here the idol Machomet combats Christ on the crucifix, and the crucifix will win.[3947] The Amiravissus (apparently the Muslim ruler of Jerusalem) subsequently laments the imminent fall of the city (1099) and twice

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[3942] E. Doutte: Mahomet Cardinal, in *Memoires de la societe d'agriculture... sciences et arts de la Marne*; Second serie; Vol 1; 2nd part; Chalons; 1899. pp 233-43.
[3943] Sir J Mandeville: *The Travels of Sir John Mandeville* (Harmondsworth; Penguin; 1983), pp. 108-9
[3944] M. T. D'Alverny: Pierre le venerable et la Legende de Mahomet: *A Cluny, Congres Scientifique*... 9-11 July 1949; CNRS; 1950; pp 161-170; at p. 163. in M.T. D'Alverny: *La Connaissance de l'Islam dans l'Occident Medieval*; ed by C. Burnett (Variorum; 1994).
[3945] J.V. Tolan: Muslims as pagan idolaters in Chronicles of the First Crusades; in *Western Views of Islam* (Blanks-Frassetto ed); op cit; pp. 97-117; at p. 105.
[3946] Petrus Tudebodus: Historia; Paris; 1977; in J.V. Tolan: *Muslims*; p. 105.
[3947] Ibid.

invokes 'Machomet and other gods.'[3948] The confrontation between God's army and the pagan army, as between the crucifix and the idol of 'Machomet,' can have only one outcome: Christian victory. Themes essential to Christian history: pilgrimage, martyrdom, and the fight against idolatry, combining to form a powerful apology for the crusade.[3949]

The dominant purpose of Christian polemics was to darken the image of the Prophet through distortions and lies. Hence, in *The History of Charles the Great and Orlando,* the pseudo-Turpin says:

> 'The Saracens had a tradition that the idol Mahomet, which they worshipped, was made by himself in his lifetime; and that by the help of a legion devils it was by magic art endued with such irresistible strength that it could not be broken.'[3950]

Vincent de Beauvais in his *Speculum Historiale* portrays Mohammed as skilled in magic.[3951] Hidlebert of Lemans (d.1133) Archbishop of Tours (France), describes the Prophet trying to prove his divine mission in the eyes of the people by the apparent miracle that 'a terrifying bull, secretly tamed and trained by the 'impostor,' kneels before him at his bidding.'[3952] Southern explains how a fictionalised negative image of Mohammed grew up in Europe in this period, and 'was elaborated and exaggerated according to expectations as to how such an enemy of Christendom might behave.'[3953] Hence, when Guilbert of Nogent spoke about the Prophet in his *Gesta Dei per Francos*,[3954] he may have garbled his name and pushed him a few centuries forward in time, and could neither separate fact from fiction, still he concluded:

> 'It is safe to speak of evil of one whose malignity exceeds whatever ill can be spoken.'[3955]

Davenport also notes the repeated assertion that the Prophet was subject to epileptic fits, 'to impute that morbid affection to the apostle of a novel creed as a stain upon his moral character.'[3956]

[3948] Ibid.
[3949] J.V. Tolan: Muslims as pagan idolaters; op cit; p. 105.
[3950] In D.C. Munro: The Western ; op cit; at p.331-2.
[3951] Vincent de Beauvauis: *Speculum historiale*, *Bibliotheca mundi* (Douai, 1624), vol. 3, Lib. XXIII.
[3952] H. Prutz: *Kulturgeschichte der kreuzzuge* (Berlin, 1883), p 81.
[3953] R.W. Southern: Western; in John Sweetman: *The Oriental Obsession*; op cit; p.6.
[3954] *Gesta Dei per Francos*, bk.1, caput 3 in patrologia latina, ed. J.P. Migne (Paris, 1853), Vol 156; col. 689.
[3955] In R.W. Southern: *Western Views of Islam in the Middle Ages* (Harvard University Press, 1978); p. 31.
[3956] J Davenport: *An Apology for Mohammed and the Koran* (J. Davy and Sons; London; 1869), p. 14.

Like the Messenger, the message, the Qur'an, equally faced onslaughts on the part of Christian polemicists. Many commentators, Frassetto notes, included slanderous accounts of the life of Mohammed and vehement denunciations of the Qur'an and Islam in their works.[3957] According to Guilbert of Nogent, it was a book of law which appeared by a false miracle on the horns of a cow (or bull or ox).[3958] The Qur'an, according to one of the so-called Cordova martyrs, Eulogio (who was executed for insulting the Prophet in 859, in Cordova,) has for Mary the worst of thoughts. Eulogio says that 'He will say nothing about the horrible sacrilege about Mary (in the text),'[3959] which, of course, can be easily disproved by any reading of the text.

Such medieval accounts according to Sweetman show how the ignorance of Islam persisted, and misconceptions about it have remained profound.[3960]Very often, Daniel, adds, Islam suffered untrue accounts which are deliberate, malicious misrepresentations, absurd, based on pure fantasy.[3961] C. Meredith Jones concluded that there was no better explanation for these misrepresentations than flagrant fanaticism.[3962] Which, however, went on, unaltered, in the following period.

The 'Renaissance' (15th-17th Centuries):

Schwoebel holds that Crusade views of Islam in the Middle Ages were carried over and perpetuated even 'after the main lines of the medieval world view had crumbled.'[3963] Daniel points out that the Europeans inherited from their mediaeval fathers a large and persistent body of ideas about Islam;[3964] the same accounts of Islam recurring monotonously, and even travellers who felt bound to describe Muslim doctrine with authority

[3957] M. Frassetto: The Image of the Saracen as Heretic in the Sermons of Ademar of Chabannes; in *Western Views of Islam* (Blanks-Frassetto ed); op cit; pp. 83-96; at p. 84.
[3958] In N. Daniel: *The Arabs*, op cit, p. 233.
[3959] Ibid; p.41.
[3960] J.W. Sweetman: *Islam and Christian Theology;* op cit; P. 63.
[3961] N. Daniel: *The Arabs*; op ct; p.232.
[3962] C. Meredith Jones: The Conventional Saracen of the Song of the Geste, *Speculum*; 17; 1942; pp. 201-25.
[3963] R. Schwoebel: *The Shadow of the Crescent: The Renaissance image of the Turk* (Nieuwkoop; 1967), p. 147.
[3964] N. Daniel: *Islam, Europe and Empire* (University Press, Edinburgh, 1966), Preface: xiii:

of their experience, yet just repeated statements which had been, or might have been, lifted straight out of medieval accounts.[3965] The representation of the Orient in tragedy in that period, for instance, reproducing the usual stereotypes: 'the imbecile cruelty of the rulers; the power of the Imams, and the rushed credulity of the Muslims.'[3966]

Little change happened in comparison with the medieval period except that the Islamic fiend is now the Ottoman Turk. The Turk became for most Frenchmen, according to Rouillard, the symbol of cruelty and lasciviousness.[3967] In England, the attitude of publicists, the clergy, and statesmen towards him differed very little from literary and popular attitudes.[3968] When the news reached England in 1565 that the Turkish siege of Malta had been lifted, a form of thanksgiving was ordered by the Archbishop of Canterbury to be read in all churches every Sunday, Wednesday and Friday.[3969] This special order of services refers to:

> 'Our sworn and most deadly enemies the Turks, infidels, and Miscreants… who by all tyranny and cruelty labour to root out not only true religion, but also the very name and memory of Christ our only saviour and all Christianity.'[3970]

And just as during the medieval period, such hostility was built upon distortions. Deliberate misrepresentations on the part of medieval writers who have access to accurate information has been an enduring issue in the historiography of pre-modern encounters between Europe and Islam, Blanks notes.[3971] The technique of rejection could hardly be faulted, Daniel observes.[3972] 'The dogmatic filter,' he adds, 'excluded every Islamic idea, except deformed to 'prove' a Christian argument.'[3973] Vitkus expands on this:

[3965] Ibid; pp. 23-4.
[3966] As in the play *Roxelane*; 1643; in P.Martino: *l'Orient dans la Literature Francaise au 17em et 18em siecles* (Librairie Hachette; Paris; 1906), p. 193.
[3967] C.D. Rouillard: *The Turk in French history, Thought and Literature; 1520-1660* (Paris; 1941), pp. 641-5.
[3968] F.L. Baumer: England, the Turk and the Common Corps of Christendom; in J.S. Geary: Arredondo's *Castillo Inexpugnable de la fee*: Anti Islamic propaganda in the Age of Charles V. in J. V. Tolan. Ed: *Medieval Christian Perceptions of Islam* (Routledge; London; 1996), pp 291-311; p 292.
[3969] S. C. Chew: *The Crescent and the Rose* (Oxford University Press; 1937), p. 443.
[3970] *A Short form of Thanksgiving to God*..... ed by W. K. Clay (Cambridge; 1847), pp. 532-33.
[3971] D.R. Blanks: Western Views of Islam in the Premodern Period: A Brief History of Past Approaches; in *Western Perceptions* (Blanks-Frassetto ed); pp. 11-53; p. 22.
[3972] N. Daniel: *The Cultural Barrier*; op cit; p.165-6.
[3973] Ibid; p. 166.

> 'The early modern image of Islam, as seen through Western eyes, is one that has been radically transformed by time, distance and cultural mediation that it bears little resemblance to the religion and the culture that it purports to describe. In fact, the representation of Islam in medieval and Renaissance Europe, is at times almost the opposite of its alleged original. Through a process of misinterpretation and demonisation, iconoclasm becomes idolatry, civilisation becomes barbarity, monotheism becomes pagan polytheism, and so on. And yet, these twisted stereotypes are, in a sense, real. They are real because, for the vast majority of medieval and early Europeans, they served as the only available means for understanding (or perhaps we should say misunderstanding) Islam. These representations are also 'real' in the sense that any such representation has a material and ideological impact as a historical phenomenon: it is a mode of perception that shapes the way people think and therefore the way they act.'[3974]

In the contemporary work, *Castillo inexpugnable de la fe*[3975] (The Impregnable Castle of the Faith), written at the behest of Charles V, Geary explains that Arredondo (the author) espoused many of the standard medieval stereotypes of Islam, just as many Renaissance authors, taking their cue from a long list of medievals, resorted to caricature and distortion in their accounts of Islamic religious ideas.[3976] The *Castillo* pursued a medieval tradition in which particular perceptions and misrepresentations about the Prophet and Qur'anic revelations are rooted in the theological conception of Christian unity.[3977]

European envoys' travels to the Muslim lands hardly changed the distorted depictions. Gunny focuses on Herbert, the attaché to the British Embassy in Persia.[3978] One of Herbert's claims was that:

> 'Some men keep a lock on top of the head by which Muhammad may distinguish them from Christians on Judgement day and by which he will lift them to paradise....'[3979]

[3974] D.J. Vitkus: Early Modern Orientalism: Representations of Islam in 16th and 17th century Europe; In *Western Perceptions* (Banks-Frassetto ed); op cit; pp. 207-30. p. 207.
[3975] Published on June 23; 1528 by Juan de Junta; in J.S. Geary: Arredondo's *Castillo;* op cit*;* p. 292..
[3976] J.S. Geary: Arredondo's; p. 292.
[3977] *Ibid.*
[3978] A. Gunny: *Images of Islam in Eighteenth Century Writing* (Grey Seal, London, 1996), p.11.
[3979] Ibid.

Herbert also states that it was from his parents that the Prophet: 'sucked knowledge of both religions'. Obviously Herbert was blind to the fact that the Prophet was an orphan. Herbert also holds that the Prophet, although circumcised, was baptized by Sergius, a 'Sabeeian heretic who denied the Trinity'. With such 'help' the Prophet 'concocted' the Qur'an and by money and force subjected the rest of his followers.[3980] Herbert adds that all Muslims invoke the Prophet four times a day, and expect his coming patiently.[3981] Of course, none of this is accurate in Islam.

Much that was imputed to Islam arose, indeed, in the imaginations of European writers.[3982] Chew notes the absurd writing about the Qur'an seemingly including stories of beasts saluting Mahomet and of the moon descending from heaven to visit him.[3983] The Qur'an contains no such stories.

> 'The currency of these and other fables,' [Chew explains,] 'shows that hostile writers seldom troubled to acquaint themselves with the Latin text; and if they did so their prejudice blinded them to the beauty and grandeur which would else surely have glimmered, albeit obscurely, through the unworthy rendering of the original.'[3984]

One usual theme of Western polemics remained Muslim 'sexual perversion;' both sexual excesses and sexual repression emphasised in Western accounts. The notion of a veiled, hidden lust that masquerades as virtue and chastity is typically a characteristic of the Islamic woman in Western European texts.[3985] The virtuous Muslim woman often converts to Christianity 'saved' by the love of a good Christian man.[3986] Sexual perversity is seen to be intrinsic in the teachings of Islam.[3987] Hence, George Lengherand, mayor of Mons in Hainault, who visited Palestine and Egypt in 1486, stated that:

> 'Muslims believed blessedness consisted of food, drink, luxuries, and in all sensualities, and pleasures which excite the body, even sodomy. Mohammed decreed that those who did not live in such

[3980] Ibid.
[3981] Ibid.
[3982] N. Daniel: *Islam, Europe*; op cit; p. 23.
[3983] Burton: The Anatomy of Melancholy; III; iv; i.3; in S.C. Chew: *The Crescent*; op cit; p. 438.
[3984] S. C. Chew: *The Crescent*; p. 438.
[3985] D.J. Vitkus: Early Modern Orientalism; op cit. p. 223.
[3986] D. Metlitzki: *The Matter of Araby*; op cit; pp. 177 ff.
[3987] Z. Sardar; M-W. Davies: *Distorted Imagination*; op cit; p.41.

pleasures would perish… and His Alcoran was full of errors. I believe it is the greatest horror in the world.'[3988]

Christian writers not only criticised Islam for offering sensual pleasure as a reward to the virtuous in the next life, they also condemned the sexual freedom allowed in this life under Muslim law.[3989] Islamic regulations governing concubinage, marriage, and divorce were at once misunderstood and reviled by Western Europeans.[3990] Alexander du Pont in his *Roman de Mahomet* maintains that the Prophet (PBUH) permitted every Muslim to marry ten wives and every Muslim woman to marry ten times as well.[3991]

In the view of Western Christian polemists, the progress of Islam could only be due to sexual permissiveness combined with violence. Vitkus observes how Islam was defined and caricatured as:

> 'A religion of violence and lust-aggressive jihad in this world, and sensual pleasure promised in the next world. But if the doctrines of Islam were so obviously worthy of scorn, what could account for the widespread, rapid growth of Islam? Force of arms and successful military aggression, violent conversion by the sword- these are often cited by Christian writers in the early modern era as an explanation for the astonishing achievements of the Islamic conquests. The early Arab Muslims are described as powerful bandits and plunderers united by a voracious appetite for booty.'[3992]

A number of techniques were used to distort the Islamic faith and the life of the Prophet. Holt studies this through the writing of Prideaux. Prideaux, Dean of Norwich (d.1724), compiled his work on the Prophet: *The True Nature of imposture etc,* completed in 1697.[3993] Holt looks at the sources Prideaux uses and his methodology. Prideaux presents a well documented work in appearance, so that he 'may not be thought to draw this Life of Mahomet, with design to set forth his imposture in the foulest of colours the better to make it serve (his) present purpose.'[3994] In his account

[3988] *Voyage de George Lengherand*, ed Charles Denys (Mons, 1861), pp. 181-2.
[3989] D.J. Vitkus: Early Modern Orientalism: op cit; p. 223.
[3990] N. Daniel: *Islam and the West* (One World; Oxford; 1993), pp.135-40.
[3991] Ibid; p. 145.
[3992] D.J. Vitkus: Early Modern Orientalism; op cit; p. 217.
[3993] P.M. Holt: The Treatment of Arab History by Prideaux; Ockley and Sale. In *Historians of the Middle East*; Ed B. Lewis and P.M. Holt (Oxford University Press; London; 1962), pp. 290-302. pp. 291-4.
[3994] Ibid; p. 293.

Prideaux lists 36 Arab authors or works, and makes great display of their names in his footnotes. This, of course, seeks to give his work legitimacy. However, as Holt observes, upon examination, it becomes clear that his knowledge of them was second hand, either from translations or quotations in the works of Orientalists. Together with these 'Arabic' sources, Prideaux uses the writings of anti Muslim controversialists. Thus, as Holt notes, the resulting biography is a combination of Muslim tradition and Christian legend, 'inspired by a sour animosity towards its subject.'[3995] And commenting on Prideaux's work, Daniel holds that it 'outdoes almost any medieval writer in its virulence.'[3996]

The 18th Century:

Just as in previous periods, the same themes of attacks on Islam and the Prophet prevailed. The character assassination of the Prophet takes first place.[3997] The general view is that the Prophet gratified the Arabs:

> 'Passions and corrupt affections which he found them strongly addicted to, especially those of lust and war. In this way he found it easier to draw them into his party.'[3998]

Muslim 'sexual perversions,' indeed, taking first place, again. In his *Memoires,*[3999] Prevost holds that the Turks, Moors and Corsairs do not just have a shadowy existence, and an obsession for plunder, but also express sexual pleasures and cruelty, and all at once.[4000] Venture, for his part,[4001] asserts categorically that there is no such a thing as delicate men or women amongst the Muslims.[4002] J.G. De Saint-Sauveur emphasised amongst the Muslims of North Africa the vice of lust:

> 'The Turks and Algerians, not anxious for large families, behave as true pirates on the marital bed. They ravage the field of sensual delight without making any effort to have them bear fruit. The women, resigned to their fate, suffer further insults since almost

[3995] Ibid; p. 294.
[3996] N. Daniel: *Islam and the West*; p. 309.
[3997] D.A. Pailin: *Attitudes to Other Religions* (Manchester University Press), 1984; p. 91.
[3998] Prideaux; Parley in D.A. Pailin: *Attitudes;* op cit; p. 101.
[3999] A. Prevost: *Memoires pour servir a l'Histoire de Malte* (Paris; 1741).
[4000] A. Prevost: Memoires; op cit; In A. Gunny: *Images;* op cit; p.170.
[4001] J. Michel Venture de Paradis: *Memoires sur la Barbarie en general* (Paris; 1983).
[4002] Manuscript. BN, Fonds Francais 6430, commentary on f.76 at f.162. In. A. Gunny: *Images;* op cit; p.193

none of these petty sultans, taking Jupiter of Greek mythology as a model, hesitate to abandon Hebe for Ganymede.'[4003]

The impression was that a religion that gave full indulgence to the ambition, the lusts and cruelty of mankind, could not fail to gain proselytes.[4004]

Sexual depravity and also the use of the sword, in contrast with Christianity, 'the religion of love', 'explain the advance of Islam.' The 'religion of Mohammed,' according to Tillotson, 'is famously known to have been planted by force at first, and to have been maintained in the world by the same violent means.'[4005] In Les Ruines, Volney announced that 'Mohammad succeeded in building a political and theological empire at the expense of those of Moses' and Jesus' vicars'; or, in the scene where he has an imam speaking about 'the law of Mohammad', 'God has established Mohammad as his minister on earth; he has handed over the world to him to subdue with the sabre those who refuse to believe in his law'. [4006] Volney denounced the 'apostle of a merciful God, who preaches nothing but murder and carnage', the spirit of intolerance and exclusiveness that 'shocks every notion of justice'; and that Christianity might be irrational, but it was gentle and compassionate, Volney declared.[4007]

18th century, supposedly enlightened minds, without exception, though, still relate facts about Islam that contradict reality. Thus, in his letter 67 (of his work *Lettres Persannes*), Montesquieu holds that:

> 'Mohammedan faith deprives women of their freedom,... and Mohammedanism locked women behind bars... and had that religion conquered the earth, women would have been imprisoned everywhere.'[4008]

[4003] J.G. De Saint-Sauveur's *Enyclopedie* in L. Valensi: *North Africa Before the French Conquest; 1790-1830*; trans by K. J. Perkins (Africana Publishing Company; London; 1977), p. xx.
[4004] F. Atterbury: Sermons and Discourses; I; p. 130; in D.A. Pailin: *Attitudes;* op cit; p. 101.
[4005] Tillotson: Works; I; p. 148; in D. A. Pailin: *Attitudes*; p. 103.
[4006] Volnay: Les Ruines; in Z. Sardar; M-W. Davies: *Distorted Imagination*; op cit; pp. 46-7.
[4007] Ibid.
[4008] Montesquieu; Pensees; p. 508; 1622. in Pauline Kra: *Religion in Montesquieu's Lettres Persanes*; Institut et Musee Voltaire (Geneve; 1970), p. 113.

In letter 24, he asserts that this religion (Islam) is so much 'discriminating against women, that they are not just forbidden to read the scriptures, but also that they were not to ender paradise because of their sex.'[4009]

Obviously, Montesquieu shows little knowledge of the Qur'an. Sura XLIII; verses 69-71 give a good place for women in paradise, as it says:

> '(Ye) who believed Our revelations and were self surrendered.
> Enter the Garden, ye and your wives, to be made glad.
> Therein are brought round for them trays of gold and goblets, and therein is all that souls desire and eyes find sweet. And ye are immortal therein.'

Alexander Ross, in his *Pansebeia*, dated from the last decade of the 17th century, insists that the Muslims rever the sun and moon,[4010] which, of course, is not the case.

Herbelot in *Bibliotheque Orientale,*[4011] claims that when Muslims 'refer to the Trinity, they easily accept that the first person-the father-is the essence of God, the second person-the Son-is wisdom and that the third-the Holy Ghost-is life.'[4012] This is utterly wrong, for one of the main dividing lines between Islam and Christianity is this matter of Trinity, as in Islam the Oneness of God is absolute, and Mohammed and Jesus are Prophets only.

In the same vein, Herbelot also holds that 'Muslims believe that most mad people are saints and that some wisdom resides in madness.'[4013]

Herbelot ought to have known that in Islam, there is no sainthood, and mad people are not even allowed in mosques let alone listened to for their wisdom.

Boulanger in 1766 writes[4014] that everything took place on the tenth day of Muharram for the Persians: the floods, the same day the Qur'an was sent from heaven, and Hussein, Ali's son was killed at Kerbala by Omar's followers.[4015] All of this, of course, has no true historical foundation, for neither was Hussein killed by Omar or his followers, but instead was killed during the Umayyad rule (which began in 661, whilst Omar died in 644), and even more importantly, the Qur'an was not revealed in one day but in phases during the Prophet's life in Makkah and Madinah.

[4009] Montesquieu: Letter 24; in P. Kra: *Religion*, op cit; p. 114.
[4010] A. Ross: *Pansebeia, or A View of All Religions in the World;* London; 6th ed (1696); pp. 118 ff.; in D.A. Pailin: *Attitudes*; op cit; p. 82.
[4011] B. Herbelot: *Bibliotheque Orientale* (Paris; 1697), (The Hague; 1777).
[4012] In A. Gunny: *Images;* op cit; p. 52.
[4013] Ibid.
[4014] N.A. Boulanger: *L'Antiquite Devoilee par ses usages* (Amsterdam; 1766).
[4015] Ibid; p.99.

Volnay in *Voyage in Egypt and Syria,*[4016] asserts categorically that Islam fails to fix the obligations or rights of individuals, groups and classes.[4017] Which is, of course, contradicted by the Qur'an. The index on legislation in the Qur'an includes matters such as bequests; arbitration, blood-money, bribery, charity, contracts, children etc…[4018]
Concluding on such distorted depictions of Islam by Christians, Pailin observes:

> 'With a few exceptions, Islam is examined in order to show that it is inferior to Christianity and offers no plausible threat to the various proofs of the truth of Christian revelation. Christian apologists are not interested in establishing and stating the truth about Muslim faith and practice. They use or abuse Islam in order to support their own convictions about the perfection of Christianity and to exhort their fellow believers to a better practice of their faith.'[4019]

From the 19th Century to the Present:

Travellers to, and writers on the Muslim world, overwhelmingly give the same image of both faith and adherents as before. Lane,[4020] for instance, although claiming his judgements were unemotional and unerring, highly specialised and all encompassing, as he himself says 'What I have principally aimed at in this work is correctness,'[4021] still found the Orientals:

> 'Indolent, superstitious, sensually over indulgent and religiously fanatical.'[4022]

Chateaubriand, as soon as he reaches the coast of Palestine, notes:

> 'The Arab, drifting along the coast, follows with an eager eye the vessel which passes in the horizon; he is waiting for a corpse out of a sea-wreck to plunder it.'[4023]

[4016] C. Chasseboeuf (Volnay): *Voyage en Egypte et en Syrie* (Paris, Mouton and Co; 1959 ed).
[4017] Ibid; p. 372.
[4018] M.M. Pickthall: *The Meaning of the Glorious Qur'an* (Ta ha Publishers; London; 1930), p. 463.
[4019] D. A. Pailin: *Attitudes*; op cit; p. 104.
[4020] E.W. Lane: *Manners and Customs of the Modern Egyptians* (London; 1836).
[4021] In N. Daniel: *Islam,* op cit; p. 52.
[4022] E.W. Lane in R. Kabbani: *Europe's Myths of Orient* (Mc Millan; 1986), pp. 38-9.
[4023] Chateaubriand: Itineraire; in D. Brahimi: *Arabes des Lumieres et Bedouins Romantiques* (Le Sycomore; Paris; 1982), p. 131.

In Constantinople, he no longer sees Muslims walking the streets, but instead sees a herd in the claws of the double authority of the imam and the Janissary.[4024]
Eliot Warburton's *The Crescent and the Cross*, was a very popular work, and was edited eighteen times, the last as late as 1888. Warburton describes the Egyptians fundamentally as 'sensualist and a slave…. He is only to be a subject in the basest of all kingdoms.' The women have all the insipidity of children without their innocence or sparkling freshness. Their beauty, voluptuous and soulless, appeals only to the senses.' As for the male:

> 'The Muslim purchases his wife as he does his horse; he laughs at the idea of honour and of love.'[4025]

Islam, itself, just as before is nothing but a corrupt heresy. Sir William Muir, writing in the last years of the 19th century, says:

> 'To put the matter shortly, each religion is an embodiment of its Founder. Mahomet sought power; he fought against those who denied his claims; he put a whole tribe to the sword.. He cast aside, when they had served his purpose, the Jewish and Christian Scriptures, and he engrafted his faith on the local superstition of his birthplace. He did all these things under cover of an alleged divine authority, but he did no miracle.
> The life of Jesus is all in contrast. He spoke and taught as one having the inherent authority in Himself; but He could also say, 'The works that I do in My Father's name, they bear witness of Me'. He was holy, harmless, undefiled. He pleased not Himself. Though rich, he became poor, that we through His poverty might become, rich. He made Himself of no reputation, and took upon Him the form of a servant. He was despised and rejected. He humbled Himself, and became obedient to death, even the death of the cross.'[4026]

For Scott, an otherwise fervent admirer of Islamic civilisation, the Qur'an is a sum of Jewish and Christian 'legends; rules for the ceremonial of Islam.'[4027] 'Mohammed,' Scott adds:

> 'Having derived his idea of heaven indirectly from the Chaldean accounts of the garden of Eden, and that of the devil from the dualism of Persian mythology, borrowed the name and

[4024] Chateaubriand: *Itineraire de Paris a Jerusalem* (1969); pp. 941-2.
[4025] E. Warburton: *The Crescent and the Cross* (New York; Wiley and Putnam; 1845), I; p. 65 f.
[4026] Sir W. Muir: *Mahomet and Islam* (London; 1895), pp. 249-50.
[4027] S.P. Scott: *History:* vol 1; p. 106.

> description of the place of torment from the Jews, who denominated hell Ge-Hinnom, literally, the 'Vale of Hinom.'[4028]

The same for J.D. Bate (1836-1923) who served as a missionary in India (1865-1897), and who also contributed many articles to the Missionary Herald and the Baptist Magazine, saw:

> 'The credit for founding Islam is Muhammad's alone... its distinctive peculiarities are all his own. He alone is responsible for its faults and he alone is entitled to all the credit, whatever it may be, of being its sole founder.'[4029]

Montgomery Watt shifts somehow, and says, that whilst it is divine, the Qur'an includes errors:

> 'What other believers in God would hope for would be that Muslims would find a way of maintaining the general truth of the Qur'an, but without denying that in some secondary matters there were slight errors…'[4030]

Just as in the past, Islam still remains a corrupt, sensual faith. Thus, E.A. Freeman, judges 'the West to be progressive, monogamous and Christian,' the East as 'stationary, arbitrary, polygamous and Mahometan.'[4031] For Chateaubriand, Muslims spend their time 'either devastating the world, or sleeping on carpets amidst women and perfumes.'[4032] Which is also the point made by J.D. Bate, who says that:

> 'Islam succeeded by corrupting its followers. Men had even converted to Islam to indulge their 'brutal appetites for sexual pleasure…'[4033]

Burton goes one step further, projecting every imaginable kind of sexual perversion onto the Orient, announcing to his contemporaries that whatever they could not find in their Victorian homes, they would find in the Orient, and that whatever was not permissible in England was permissible in Egypt where women are used to being treated as chattel.[4034]

Being sexually perverse, apparently does not prevent Islamic society from enslaving women. In 19th century Westerners' eyes, women in Islam are

[4028] Ibid; p.109.
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[4030] W.M. Watt: *Muslim Christian Encounters* (Routledge; London; 1991), p. 137.
[4031] E.A. Freeman: *The History and Conquests of the Saracens* (Oxford: John Henry and James Parker; 1856; London Mc Millan 1876), 3rd ed. pp; i.4.
[4032] Chateaubriand: *Itineraire de Paris a Jerusalem;* op cit; pp. 908.
[4033] J.D. Bate: *The Claims of Ishmael*; op cit; pp. 285; 253.
[4034] In Z. Sardar; M.W. Davies: *Distorted Imagination;* op cit; pp. 51-2.

only seen 'in terms of subjection, enslavement and concubinage.'[4035] The Oriental men are, thus:

> 'Cruel captors who hold women in their avaricious grasp, who use them as chattels, as trading-goods, with little reverence for them as human beings.'[4036]

In the writings and paintings of the French Romantics movement, the woman becomes for the fanaticised, brutal Muslim a prize of war and piracy; the Muslim prowling upon her, and ravaging her.[4037] Thus Helena, heroine of a poem by Alfred de Vigny, is violated brutally by the Turks; an act de Vigny dwells upon in every single, morbid detail. In the *Orientales* of Victor Hugo, all women are prisoners at the Seraglio, and are offered to the beastly delectation of the Sultan. All these women are young and virgin.[4038] These victims of Turkish beastly desires are generally convent girls kidnapped by pirates (Muslims), and taken to the Harem of the Sultan.[4039] Countless tales in poems and fiction also speak of women enrobed in sacks and thrown alive in rivers' tumultuous waters,[4040] and women instantly murdered by their husbands for raising their veils in the sight of another man.[4041]

The 'barbarism' of the Eastern male contrasts, of course, with the 'civilised' behaviour of the Western male. One tied women up and sold them at slave auctions; the other revered them and placed them on pedestals.[4042] Thus, the French writer, Dumas, writes:

> 'Woman in our life is a wife, a sister, a friend, in theirs (the Muslims) she is a slave, the most unfortunate of all slaves. Her life is that of a prisoner, none other than her master comes near her. The more attractive she is, the more unhappy, because then, her life is suspended on a thread, she raises her veil, and her head falls.'[4043]

The Western sympathy for the 'pitiful female victim of the Muslim man' is caught in paintings. Kabbani goes through a number of such paintings.[4044] John Faed's 'Bedouin exchanging a slave for armour', dating

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[4036] R. Kabbani: *Europe's Myths of the Orient* (Mc Millan; 1986), p. 78.
[4037] C. Grossir: *L' Islam;* op cit; p. 99 fwd.
[4038] V. Hugo: *Les Orientales*; 1964; Les *Tetes du Serail*; IV; pp. 602-3.
[4039] Ibid. *Chanson de Pirates*; p. 619.
[4040] J. Merimee: la Double Meprise; in C. Grossir: *L'Islam*; op cit; p. 102.
[4041] V. Hugo: *Les Orientales*; op cit; *Le Voile*; p. 625.
[4042] R. Kabbani: *Europe's Myths*; op cit; 78.
[4043] A. Dumas: *Quinze Jours au Sinai* (Plan de La Tour; 1979), p. 7.
[4044] R. Kabbani: *Europe's Myths*; op cit; pp. 78-9.

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[4040] J. Merimee: la Double Megprise; in C. Grosser: *L'Islam;* op cit; p. 102.
[4041] V. Hugo: *Les Orientales;* op cit; *La Voile;* p. 625.
[4042] R. Kabbani: *Europe's Myths;* op cit; 78.
[4043] A. Dumas: *Quinze Jours au Sinai* (Plan de La Tour; 1979), p. 7.
[4044] R. Kabbani: *Europe's Myths;* op cit; pp. 78-9.

from 1857, shows the Bedouin with an almost entirely naked slave-girl exhibited in the stall of a sword merchant. The girl's body is inspected in such meticulous, very searching manner, her worth assessed in armour. Her expression, Kabbani notes, 'is a piteous one... completely helpless; naked, bound, female, and a slave.' The Muslim, on the other hand, is predatory, lecherous, gross, and loathsome.
Another slave-market scene is Gérôme's 'Le Marché d'Esclaves,' where the slave girl is in the midst of would be purchaser men. The girl, again, is naked, offered to the gaze of her captors and would be buyers. The Muslim owner, holding her head veil is 'a ghoulish-looking man,' just as Muslims are always depicted: frightening with their gross, dark complexions, their hairy faces, big, bulging eyes, thickened lips… Four other victims await their turns for inspection, still shrouded in their veils.[4045]

The same depiction of `Muslim barbaric treatment of women' contrasting with Western sympathy for her fate is found today. It is needless to reproduce the intense media barrage on the Islamic cruel oppression and shackling of womanhood, just as it is needless to linger on the tragic-comical situation whereby murderous dictatorships in the Muslim world become welcomed in the world of 'the free and the good' as soon as skimpily dressed women fill the screens of their television channels alongside porn. Here a brief focus is placed upon the issue of the veil, this garment deemed the symbol of Islamic oppression of women par excellence. All that is needed here is the extract from the back cover of a book, which captures in a few lines the horrors that the veil represents.[4046] From the title of the book: *Le Voile contre l'Ecole,* (the Veil as the Enemy of Education), the veil becomes an attire that hinders Muslim women's social progress, and even deprives them of education. Which is remarkably odd, for veiled Muslim women do not just attend colleges and universities in considerable numbers, but also exert functions of surgeons, journalists, high officers in the administration, ministers, can own and operate businesses, and so on and so forth. It is also odd to find that it is precisely the `liberating, progressive' forces who deem the veil symbol of persecution, who took the step to ban veiled girls from schooling in France, in 2004-5. And just as Lueg comments:

[4045] Ibid.
[4046] Elizabeth Altschull: *Le Voile Contre l'Ecole (The Veil Against School)* (Le Seuil; Paris; 1995).

> 'Clearly the cliché of the oppressed Islamic woman serves the purpose of distracting us from things that are wrong in our own society.'[4047]

Of course, we have the daily association of Islam with violence and terror, so dense a barrage, that at a fairly recent Question Time on the BBC, a guest judiciously noted how when children in the UK are asked today what is a Muslim, the answer from all was: a terrorist.[4048] The image of the Muslim terrorist so enduring, and yet conflicting so much with reality. Indeed, on the ground, those victims of state terrorism, countless thousands, slain from one end of the world to the other, or political prisoners, with, or generally without, trial, are, in general, Muslims.

Concluding Words:

A dark picture was painted of Islam, such that every crime imaginable was popularly associated with the Prophet, says Smith.[4049] Daniel, too, summing up the Western view of Islam, concludes that nonsense was accepted, and sound sense was distorted.[4050] Attacks on Islam, which Daniel notes, are 'most divorced from reality, and most remote from any contact with Islam.'[4051] Bucaille, equally, has concluded that the erroneous statements made about Islam in the West are the result of systematic denigration.[4052] Lueg for her part, rightly insists that the threat of Islam often stems from a limited vision rather than reality, and that anything we hear from the Islamic world, we assume to be stated from an inferior position and in a religious context, ie., that of Islam.[4053] Van Ess, meanwhile, has re-currently pointed to the anti Islamic clichés, which lay deep in the subconscious and meet with unanimous approval.[4054]

[4047] A. Lueg: The Perception of Islam in the Western debate; in *The Next Threat*; ed by J.Hippler and A. Lueg (Pluto Press); pp. 7-31; at p. 20.
[4048] BBC 1 Question Time; early 2003, seen by this author.
[4049] R. B. Smith in C. Bennett: *Victorian Images of Islam* (Grey Seal; London; 1992), p. 77.
[4050] N. Daniel: *Islam and the West*; op cit p.302.
[4051] N. Daniel: *The Arabs;* op ct; p.232.
[4052] M Bucaille: *The Bible, op cit.* p. 1.
[4053] A. Lueg: The Perception of Islam; op cit; pp. 28; and 21.
[4054] J. Van Ess: Islamic perspectives; in H. Kung et. al: *Christianity and the World Religions* (Doubleday; London, 1986), p. 6.

It is, thus, all too normal that these very anti Islamic clichés transfer straight to the manner of dealing with Islamic civilisation.

3. Islamic Civilisation and Western Denial:

At a fairly recent intervention, Prince Charles, referred to the 'ignorance' about the debt Western culture owes to the Islamic world, a failure, he points out, 'which stems from the straightjacket of history, which we have inherited.'[4055] 'Because we have tended to see Islam as the enemy of the West, as an alien culture, society, and system of belief,' he concludes, 'we have tended to ignore or erase its great relevance to our own history.'[4056]
Glubb goes a little further:

> 'If knowledge of the history of the period from the 7th to the 12th centuries is vital to the comprehension of the development of Europe, why, it may be asked, had it never been taught?' he asks, before giving his own explanation:
> 'Throughout these five hundred years, Christendom lived in constant fear of Muslim conquest. From the 12th to the 15th centuries, Islam and Christendom were equally balanced. The West was overtaking and gradually surpassing the Muslim countries in power.... But throughout the Renaissance period in Europe, fear of the Muslims was still strong and hostility, political and commercial as much as religious, was intense. Doubtless as a result of these factors, the indebtedness of Western Christendom to Arab civilisation was systematically played down, if not completely denied.'[4057]

Vitkus, equally notes:

> 'The demonisation of the Islamic East is a long and deeply rooted tradition in the West-spanning the centuries, from the early medieval period to the end of the 20th century. It harks back to ancient representation of Eastern empires and invading hordes that predate Islam, including the Assyrians and the Persians of the Ancient world. The classical and biblical stereotypes that were

[4055] H.R.H Prince of Wales: *Islam and the West* (Oxford Centre for Islamic Studies, Oxford, 1993).
[4056] Ibid.
[4057] J. Glubb: *A Short History*; op cit; p.289.

> established in the collective consciousness of the West were further sharpened and solidified later by the historical experience of 'Holy War' that began with the rise of Islam, continued during the period of the crusades, and endured during the Spanish Reconquista and Ottoman imperialism. In Western Europe, a long history of military aggression and cultural competition (taking place primarily, but not entirely, in the Mediterranean basin) served as the basis for the prevailing conception of the Islamic 'Orient' during the 16th and 17th centuries.'[4058]

According to Scott, this hostility meant that no subject has been treated with as much neglect and flagrant injustice as Islamic civilisation:

> 'Its story' (Islamic civilisation), he says 'has been written in the majority of instances by the implacable enemies of those who founded and promoted it. Theological hatred has lent its potent aid to the prejudice of race and the envy arising from conscious inferiority to deny or belittle its achievements.'[4059]

The hostility to Islam impacting on the history of Islamic civilisation was also noted by Daniel,[4060] Sardar and Davies,[4061] Southern,[4062] and Smith.[4063] And like much else, the origins of this go back to the Middle Ages.

Throughout the Middle Ages, Tolan explains, 'both as a rival religion and as a rival civilization, Islam was tremendously successful. It was hence appealing, intriguing, and frightening. The attraction of Muslim learning, Muslim culture, and Muslim sophistication was extremely strong... But the more Christians were attracted to Islam, the stronger others felt the need to condemn it-for it was this attraction, more than the might of Muslim armies, that was most threatening to Christendom.'[4064]
Blanks and Frassetto elaborate on this:

> 'During the Middle Ages, Islamic civilisation was so far ahead of its Christian rival, offering enticing advances in architecture, law, literature, philosophy, and indeed in most areas of cultural activity. It was therefore from a position of military and perhaps,

[4058] D.J. Vitkus: Early Modern Orientalism; op cit; pp. 208-9.
[4059] S.P. Scott: *History;* Vol ii; op cit; p.595.
[4060] N. Daniel: *The Arabs; op cit; p.* 1975.
[4061] Z. Sardar; M-W. Davies: *Distorted Imagination*; op cit.
[4062] In R.W. Southern: *Western Views;* op cit.
[4063] R.B. Smith: *Mohammed and Mohammedanism* (London; Smith, Elder & co; London; 1876).
[4064] J.V. Tolan ed: *Medieval;* op cit; pp. xix-xx.

more importantly, cultural weakness that Christian Europe developed negative images, some of which survive to the present day. In part, this hostility was the result of continued political and military conflict, but it likewise ensued from a Western sense of cultural inferiority.

Thus the Western need to construct an image of the Muslim, of the other, was a twofold process that came to dominate the pre modern discourse concerning Islam.

On the other hand, it created an image of the Saracen, Moor, or Turk that was wholly alien and wholly evil. In both popular and learned literature, Muslims were portrayed as cowardly, duplicitous, lustful, self indulgent, pagans who worshipped idols and a trinity of false gods. On the other hand, the creation of such a blatantly false stereotype enabled Western Christians to define themselves. Indeed, the Muslim became in a sense, a photographic negative of the self perception of an ideal Christian self image, one that portrayed Europeans as brave, virtuous believers in the one true God and the one true faith. By debasing the image of their rivals, Western Christians were enhancing their own self image and trying to build a self confidence in the face of a more powerful and more culturally sophisticated enemy.'[4065]

Daniel, too, notes how in an age of encounter, when many conversions to Islam were taking place, the detailed Christian presentation of Islam 'had to be what it was, intended perhaps to deter Christians who might be curious about it.'[4066] Thus, it made it 'possible to protect the minds of Christians against apostasy and, gave Christianity self respect in dealing with a civilisation in many ways its superior'.[4067] The image that was created of Islam was that Christians were fighting forces of darkness, something that was necessary to compensate for Western Christendom's feeling of inferiority.[4068]

Whatever arrived from the land of the Muslim foe was regarded with dread. Savage observes how ecclesiastical and university administrators were quite conscious that Muslim learning was feared as disturbing to the curriculum of the medieval university and the pattern of thought taught

[4065] D.R. Blanks-M. Frassetto: Introduction; in *Western Perceptions* (Blanks-Frassetto ed); op cit; p. 3.
[4066] N. Daniel: *The Cultural Barrier*, op cit; p.158.
[4067] N. Daniel: *Islam and the West* (Edinburgh 1960); p. 270.
[4068] M.W. Watt: l'Influence de l' Islam in *Revue des Etudes Islamiques*, Vol 41; p. 154

therein.[4069] This is evident in the attitude towards the earliest transmitters of Muslim sciences to the West. Gerbert of Aurillac's (future Pope Silvestre II) (d. 1003) science, which he had learnt in Muslim Spain met with hostile reception.[4070] Rumours had abounded that 'whilst he was amongst the infidels (the Muslims) in Spain, the future pontiff had 'bartered his soul to satan, on condition that he would make him Christ's vicar upon earth.'[4071]

Nearly a century after Gerbert, Constantine the African (d.ca.1087), brought medical knowledge from Tunisia to Salerno[4072] 'at a time when Islam was thoroughly hated in Christendom.' Under the clerical pressures being brought to bear on him, Constantine had to suppress the name of Muslim authors of whose works he produced Latin versions.[4073] It was not that Constantine sought to plagiarise the Islamic works, as nearly all historians of science accuse him, he was forced to do so. Even amongst the translators of the 12th century, whose translations were to serve as foundations of Western learning, as Daniel observes, in no single case did the dependence on Islamic sources or writers, stimulate in any Latin writer 'a kindly or a tolerant thought' for Islam or its culture.[4074] The fear of Islamic 'heresy' was such, Durant notes, that the Church saw heretics as traitors who undermined the unity of Christendom in its gigantic conflict with Islam.[4075]

The same fear of, and hostility to Islam transferred to the late Middle Ages. The Humanist movement formed a peculiar aversion for the Islamic tendency.[4076] Dante's plea to Christian minds to rid themselves of their unhealthy, unholy reliance on Muslim science inaugurated a trend that soon became manifest among the first recognised Italian humanists, Petrarch, in particular, whose abhorrence of anything smacking of Muslim

[4069] H.L. Savage: Fourteenth century Jerusalem and Cairo through Western eyes, in *The Arab Heritage*, N.A. Faris edition (Princeton University Press, 1944), pp 199-220: at p.199.
[4070] M.L. Colish: *Medieval Foundations of the Western Intellectual Tradition 400-1400* (Yale University Press; 1997), p. 164.
[4071] J.W Draper: *A History*; op cit, Vol 2. p. 7.
[4072] On Constantine, see: C. Burnett and D. Jacquart: *Constantine the African* (Brill, 1994).
[4073] D. Campbell: *Arabian Medicine*, op cit; pp.123-4.
[4074] N. Daniel: *The Cultural;* op cit; p. 171.
[4075] W. Durant: *The Age of Faith*, op cit; p.777.
[4076] C. Singer: *Short History of Scientific Ideas to 1900* (Oxford University Press, 1959), p. 196:

culture is evident.[4077] In a letter to one of his learned colleagues, he says amongst others things:

> 'Before ending, a word, I beg you, so that all your Arabs should not be included in the advice you give me; I hate that race, all of it… As for the Arabs, you know what sort of medical physicians they are. I know their poets, nothing more sluggish, nothing more limp, nothing more annoying, nothing as immoral as their work…. And you, men of letters, I cannot understand by what sort of aberration of judgment you give such people so much praise, in my opinion the least deserved.'[4078]

Petrarch's humanist movement sought to resurrect Greek knowledge and to clean it of medieval (Islamic) additions; love of Greece and Rome nourished by hatred of Islam.[4079] His hostility to both science and Arabism was 'comparable to the form of modern anti Semitism associating Jewishness with radicalism,' according to Sarton.[4080] In the view of Petrarch, Muslims represented the dangerous and foreign Asia, so reviled by Ancient Greeks, and they represent barbarism itself; the Christian West, on the other hand, the bastion of civilisation, manly courage and decency.[4081] Petrarch asserts the superiority of Europeans to the 'backward Muslims' in a verse that contrasts the Northern European warrior spirit of the people who live in a land 'that always lies in ice and frozen in the snows, all distant from the path of the sun to the softness of the Muslim peoples:

> 'Turks, Arabs, Chaldeans… a naked, cowardly, and lazy people who never grasp the steel but endure all their blows to the wind.'[4082]

Petrarch, thus, as Bisaba observes, reduces formidable Muslim empires to an image of 'disorganised and uncivilised hunters and gatherers who rely

[4077] R. Lemay: Translators of the twelfth century: Literary Issues raised and impact created; in Medieval Philosophers; *Dictionary of Literary Biography*; Vol 115; Edited by J. Hackett; A Bruccoli Clark Layman Book; Detroit; pp. 367-89, at p. 376.
[4078] French translation given by Dr P. Mabile in an oppuscula titled Petrarque et les medecins, deuxieme letter a Jean de Dondi; Anger; 1870; 40 pp. (*Extraits des Annales de la Societe Lippeene de Maine et Loire*; vol XII; pp. 35-6) in M. Rodinson: Sur un passage de Petrarque concernat la literature arabe; in *Bulletin d'Etudes Arabes*; vol 11; 1951; p. 76-7; at p.77.
[4079] G. Sarton: *The Appreciation of Ancient and Medieval Science During the Renaissance (1450-1600)* (University of Pennsylvania Press, 1955), p.44.
[4080] G. Sarton: *Introduction;* vol III; op cit; p. 508; and p. 178.
[4081] N. Bisaba: 'New Barbarian' or worthy adversary? Humanist Constructs of the Ottoman Turks in fifteenth century Italy; in *Western Perceptions* (Blanks-Frassetto ed); op cit; pp. 185-205; p.189.
[4082] *Petrarch's Lyric Poems;* ed and trans R. M. Durling; Cambridge; 1976; pp. 76-7.

on archery because they lack the skill and courage to fight in hand to hand combat.'[4083] For him, the Muslims are 'the same wild Saracens the Romans encountered a millennium earlier, not the advanced civilisation of vast trade networks, great armies, large cities, and extensive learning.'[4084]

The struggle to stem Islamic influences had bloody repercussions, as discussed above, and sustained attempts were made to limit the impacts of Islamic science and civilisation. The campaign of the medical humanists against the medieval and Islamic writers led to the replacement of Ibn Sina by Latin translations from the Greek text of Galen.[4085] At the end of the 14th century, the Florentine, Niccolo Falcucci, in his *sermones medicinales* proclaimed Galen's infallibility.[4086] Symbols of Islamic culture also faced enduring hostility. Money changers in the 13th–14th century were summoned not to use Arabic numerals in their transactions and keep with the methods of the ancients.[4087] These numerals were considered an integral part of the Arabic script, whereas the Roman ones were inseparable from the Latin script.[4088] Arabic was viewed by Dante as the appropriate language for Hell.[4089] Did not the fierce Cerberus, guardian of the 'gates of Hell,' shout his warning in Arabic: 'Bab as-saitan! bab as-saitan!' (Doorway of the devil! Dorway of the devil!).[4090] In Spain, hostility extended to symbols, which bore marks of Islamic skills, and 'which were at once suggestive of heresy.'[4091] The use of private and public baths in that country, symbols of the Islamic faith, were banned, and measures were passed to that effect, all baths being forthwith destroyed, commencing with those of the king.[4092] Any clean and neat person was persecuted on the ground they might be Muslim who regularly performed his/her 'ablutions'.[4093]

[4083] N. Bisaba: 'New Barbarian;' op cit; p. 189.
[4084] Ibid.
[4085] D. Campbell: *Arabian Medicine*, op cit; p. 192.
[4086] G. Sarton: *The Appreciation of Ancient*; op cit. p.20
[4087] D.J. Struik: The Prohibition of the use of Arabic numerals in Florence: *Archives Internationales d'Histoire des Sciences* Vol 21, pp 291-4. at p. 294:
[4088] G. Sarton: *Introduction;* op cit; vol iii. P.127.
[4089] R. Lemay: Translators of the twelfth century; op cit; p. 376.
[4090] Ibid.
[4091] S.P. Scott: *History;* Vol ii; op cit; p.576.
[4092] H. C. Lea: *A History of the Inquisition of Spain*, 4 vols; The Mac Millan Company, New York, 1907. vol 3. p.336
[4093] T.B. Irving: Dates, Names and Places: The end of Islamic Spain; in *Revue d'Histoire Maghrebine;* No 61-62; 1991; pp 77-93. p.81.

By the mid 15th century, a new Islamic foe arose, the Ottomans, and soon the label of barbarism transferred onto them. Following the taking of Constantinople by the Turks in 1453, Western Christendom was awash with tales of 'Turkish atrocities,' slaughter and mass rape, and Westerners, at any rate accepted these rumours and humanists did not miss the opportunity to sell lurid tales of rapes on the high altar of Hagia Sophia in their accounts and letters.[4094] Although such accounts hardly express reality, what matters, was that humanists like most Westerners believed even the most sensational reports of violence and savagery that came their way.[4095] The Turks were now the new barbarians, and many saw them as enemies of high culture.[4096] Discourse about the Turks as inimical to learning and the arts became more and more common;[4097] their identification with barbarism nourished and intensified by their military success. Vitkus notes, how:

> 'Many of the images of Islam that were produced by European culture in the early modern period are imaginary resolutions of real anxieties about Islamic wealth and might. The Christian West's inferiority complex, which originated in the trauma of the early Caliphate's conquests, was renewed and reinforced by the emergence of a new Islamic power, the Ottoman Turks, who achieved in 1453 what the Umayyad armies had failed to accomplish in 669-674, the capture of Constantinople. A series of Ottoman invasions and victories followed, including Athens in 1459, Otranto in 1480, Rhodes in 1522, Budapest in 1526, and in 1529 when the Turks pushed on and almost took Vienna, Cyprus in 1571, and Crete in 1669.'[4098]

An English writer, Richard Knolles, in his History of the Turks (1603), refers to them as 'The scourge of God and present terror of the World.'[4099]

Hostility to Islamic learning could only intensify in the midst of dread and fear, and the place of now defunct Greece could only rise in glory. Champier's medical books, with the exception of the *Mirror of Apothecaries and Druggists*, written in Latin, in 1513, were, thus, devoted

[4094] See, for instance, Aeneas Silvius Piccolomini's description of mass rape of all segments of society as well as both sexes in his letter to Leonardo benvoglienti; ed. Pertusi; La Caduta; vol 2; pp. 62-4.
[4095] N. Bisaba: 'New Barbarian;' op cit; p.192.
[4096] R. Schwoebel: *The Shadow of the Crescent: The Renaissance Image of the Turk* (Nieuwkoop; 1967), p. 164.
[4097] N. Bisaba: 'New Barbarian'; op cit; p.193.
[4098] D.J. Vitkus: Early Modern Orientalism; op cit p. 210.
[4099] Richard Knolles: *History of the Turks* (London; 1603).

to Galenic commentaries and controversies, and to the defence of Greek against Muslim medicine.[4100] Champier insists on how the Apothecaries commonly make mistakes in several medicines contrary to the intention of the Greeks on the basis of the 'Wicked Faulty teaching of the Arabs.'[4101] Champier's attempts were to reconcile Plato with Aristotle, and Galen with Hippocrates, and to reconcile all the Greeks against 'the Arabic barbarians.'[4102] Jacobus Sylvius, in Introduction to Anatomy (1515), opined that if the eye saw in dissection something that did not concur with what Galen reported the eye must be deceived.[4103] The classically educated physicians managed to persuade one another that the Greek texts were immutable and virtually infallible, and those who wished to progress either had to get round it, or mount a head-on assault.[4104] This strength of hostility, however, only suggests that Islamic influences were very strong permeating both science and philosophy.[4105] The writings of the Islamic scholars provided much of the intellectual basis, although it was often not acknowledged.[4106]

A decisive shift occurred in the 17th century. As Blanks explains, from the 11th to the mid 17th century derisive attacks by Western authors were born of a nagging inferiority complex vis a vis Muslim civilisation, in the course of the 17th century, however, the Muslim states ceased to be a threat politically, and the West began to develop new secular views that demystified religion and diminished the threat of Islam as a rival ideology.[4107] Derisive attitudes, thus, arise not from an inferiority complex but from a Eurocentric sense of cultural superiority.[4108] Apart from the obvious belief that Western civilisation was the norm for other cultures, as Sardar and Davies observe, Orientalists also believed that Biblical tradition was the norm for all monotheism.[4109] Thus, they did not seek to understand Islam, but to dominate and ridicule it, abuse it and demonstrate its inferiority, and as Sardar and Davies insist:

[4100] G. Sarton: *The Appreciation of Ancient*; op cit. p.23
[4101] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 50.
[4102] G. Sarton: *The Appreciation of Ancient*; op cit. p.23
[4103] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 50.
[4104] Ibid.
[4105] G. Sarton: *Introduction;* vol III; op cit; p. 509.
[4106] C.J.M. Whitty: The Impact of Islamic Medicine; op cit; p. 50.
[4107] D.R. Blanks: Western Views of Islam in the Premodern Period: A Brief History of Past Approaches; in *Western Perceptions* (Blanks-Frassetto ed); pp. 11-53; p. 14.
[4108] Ibid.
[4109] Z. Sardar and M. W. Davies: *Distorted Imagination*; op cit; p. 41.

> 'Once raped, to envelop it (Islam) within Western civilization and to turn Muslims into nice, docile, subject people, an extension of the West.'[4110]

Systematised studies of the Orient were thus carried out, not out of empathy for Islam, but as Kabbani puts it, to 'devise and rule.'[4111] Thus, Sir William Jones, a servant of the East India Company, inaugurated Orientalist studies in order 'to increase Europe's acquaintance with the peoples it would exert control upon.'[4112] William Bedwell, instrumental in establishing the Chair of Oriental studies at Cambridge, aimed amongst other things at 'enlarging the borders of the Church, and propagation of the Christian religion to them who now sit in darkness'.[4113]

This, of course, slotted fittingly in the new age of imperialism and missionary activity of the 18th –19th centuries. Hitti explains how Arabic studies were conditioned by missionary activity and interest and by world politics; how such studies were carried out either to convert Muslims or to further imperialist interests. In this 'Western chauvinism, religious zeal and sheer ignorance played their part,' and Islamic society was painted dark, and its inferior character overemphasised.[4114] Which brings us to the next point.

Colonisation, and the 'Backward People':

Joseph notes how in the history of mathematics, for instance, Western writing deliberately passes scientific knowledge from the Greeks into a period of Dark Ages, then a re-discovery of Greek learning leading to the Renaissance, completely setting aside the contribution of the colonised people, so as to maintain the image of their inferiority and ease their subjugation and domination.[4115] This trend became accentuated on the eve of the Western colonial venture, with the 18th century witnessing the development of a vast literature, which as Sardar and Davies note, present the Muslims as:

[4110] Ibid.
[4111] R. Kabbani: *Europe's Myths*; op cit; p. 138.
[4112] *Ibid;* p. 43.
[4113] Quoted by J.D. Latham in Z. Sardar and M.W. Davies: *Distorted Imagination*; op cit; p. 42.
[4114] P.K. Hitti: America and the Arab heritage; in *The Arab Heritage*, op cit; 1-24:pp.9 and 14.
[4115] G.G. Joseph: *The Crest of the Peacock* (Penguin Books; 1991), at p 4.

> 'Mere preservers of Greek science, to which they added nothing themselves, thus these literary sources were readily available, as Vico argued, to pass the torch of civilisation direct from Greece to Europe, while Muslim civilisation remained un-warmed, even by the embers.'[4116]

As the Western colonial onslaught on the Muslim world intensified in the 19th and early 20th century, from mere transmitters of Greek learning, the Muslims became identified in Western with the barbaric and primitive. Doughty, for instance, says:

> 'Semites are black and white and not only in vision, with their inner furnishing; black and white not merely in clarity, but in apposition. Their thoughts live easiest among extremes. They inhabit superlatives by choice.... They are limited narrow-minded people whose inert intellects lie incuriously fallow.... They show no longing for great industry, no organisation of mind or body anywhere. They invent no system of philosophy or mythologies....'[4117]

The Frenchman Renan insists:

> 'It is the Aryan spirit which has created everything from political life, art, literature etc, 'the Semitic peoples have nothing of it, apart from some poetry... In these matters, 'we are entirely Greek.' Even the so-called Arabic sciences were a continuation of Greek sciences.... The Semitic spirit has produced monotheism, and Christianity and Islam have conquered the world, but it can produce nothing else-no myths, therefore no higher literature or art, because of the terrible simplicity of the Semitic spirit, closing the human brain to every subtle idea, to every fine sentiment, to all rational research, in order to confront it with an eternal tautology: God is God.'[4118]

The barbaric, inferior, nature of Islamic society was soon identified to have its source in the faith itself, Islam. Hence, Muir, who during British colonial rule over India acted as the Governor of the North West Province, asserts:

> 'When, again, we come to compare Islam with Christianity, and first in its secular aspects, one is immediately struck with the

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[4116] Z. Sardar and M. W. Davies: *Distorted Imagination;* op cit; p. 47.
[4117] C.M. Doughty: *Arabia Deserta,* Edition; 2 Vols (London J. Cape; 1936) First published in 1888 by Cambridge University Press; Vol 2; p. 22..
[4118] E. Renan: De la Part des peoples semitiques dans l'histoire de la civilisation' in *Oeuvres completes* (Paris, Calmann-Levy, 1947), Vol II; p. 333.

difference between the two in the virtue of adaptation to the wants and aspirations of humanity. Islam imposes a code, hard, fast, and imperative in every detail, which, however well it may have suited Arabia thirteen centuries ago, is quite unfitted for the varying requirements of other times and places. Yet it binds society hand and foot; there can be no onward upward movement, nor even the attempt to rise.

The Christian code is altogether different. It lays down principles, and not details. If there be one exception, that, namely, in respect of marriage and divorce, it is expressly based on the laws of nature. 'He', said Jesus, 'which made them at the beginning, made them male and female; ... what, therefore, God hath joined together, let not man put asunder.' The foundations of Christian morality are not less immutable than those of the Coran, but they are infinitely broader, and can be suitably built upon for all generations. Its laws are capable of being applied to the habits, thought, and institutions of all ages, and its doctrines harmonise with every upward step towards freedom, knowledge and philanthropy; indeed, we may say, themselves contain the plastic force which brings these results about.'[4119]

For Chateaubriand, the Qur'an, which he calls 'The Book of Mahomet,' is the very source of the ill:

'There is no principle of civilisation, nothing that elevates the minds and souls. This book preaches neither hostility to tyranny nor love for freedom.'[4120]

For Warburton, on the Egyptian:

'His loyalty is slavishness; his courage is ferocity; his religion, superstition; his love, sensual; his abstinence, pharisaical; his resignation, a dastardly fatalism.'[4121]

Muslim society was thus in great need of Western corrective action. Warburton insists that Britain may well have the responsibility to enter this section of the world:

'To vindicate the Cross where her best and bravest blood was shed six hundred years ago,' to bring civilisation and morality to these degenerate peoples.'[4122]

[4119] W. Muir: Mahomet and Islam; op cit; pp. 246-7.
[4120] Chateaubriand, Itineraire… p.908. in C. Grossir: *L'Islam des Romantiques*; Maisonneuve; Larose; Paris, 1984. p. 56.
[4121] E. Warburton: *The Crescent and the Cross* (New York; Wiley and Putnam; 1845), I; p. 76.
[4122] Ibid. p.242.

For the American G. W. Curtis, the people he met through Syria impress him as:

'Repulsive in appearance, the dregs of the refuse races. They look mean and treacherous and would 'offer small resistance to (Western) determination and skill.'[4123]

For Hegel, Islam signified:

'The worship of one, the absolute object of attraction and devotion'. But Islam's devotion to One was much too abstract, too excessive; indeed, it excluded an interest in the human world. This is why the Muslim mood swung like a pendulum from fanatic zeal to desperation, from one extreme to another. Because of these extremes, Islamic civilization was self destructive and on the verge of writing itself off from history. Islam now had nothing to offer except fanaticism, sexual enjoyment and despotism. Europe's destiny lay in swallowing the antithesis of Islam into a new thesis of its own.'[4124]

In order to 'civilise Islamic society,' Western powers now had to take Muslims back to their pre-Islamic roots. This is well illustrated by the colonisation of Morocco by France in 1912. Decades prior to the French colonisation, a vast literature depicted the retarding influence of Islam on Morocco.[4125] For the French historian, Moulieras, the Moroccans are intolerant fanatics, just like their co-religionists; traitors, and incapable of forming stable government owing to their hostility to authority.[4126] Authority, if it exists amongst them, is despotism, because it is a theocracy, the sultan being emperor and pope at once.[4127] The French review, *Bulletin*, dredged up many stories in the 1890s about the violence in Morocco proving that, truly, the 'Moors' were uncivilised, in need of French guidance'.[4128] Robert de Caix, a journalist, took every opportunity to show Morocco as inhabited by barbarians eager to rape and pillage.[4129] De Caix argued strongly that the time had come for France to restore

[4123] G.W. Curtis: *The Howadji in Syria* (New York; Harper; 1852), p. 132.
[4124] Hegel in Z. Sardar-M.W. Davies: *Distorted Imagination;* op cit; p. 59.
[4125] Well outlined by both M. Garcia-Arenal: Historiens de l'Espagne, historiens du Maghreb au 19em siecle. Comparaison des stereotypes; *Annales;* vol 54; 1999; pp 687-703. And J.J. Cook: The Maghrib through French Eyes; 1880-1929; in *Through Foreign Eyes;* edited by A.A. Heggoy (University Press of America; 1982), pp. 57-92.
[4126] A. Moulieras: *Le Maroc Inconnu* (Paris; 1895), pp. 21-3.
[4127] Seconzac: *Au Coeur de l'Atlas;* Paris; 1910; p. 258 in M.Garcia Arenal: Historiens; op cit; p. 691.
[4128] J.J. Cook: The Maghrib; op cit; p. 76.
[4129] Ibid; p. 83.

order in the Western Maghrib.[4130] France was to bring order and civilisation, the Moroccans having failed due to their attachment to Islam.[4131] It is Islam, which bans science, and is the source of backwardness, fanaticism, chaos, and fatalism.[4132] Therefore, it was the duty of France to bring back civilisation, which these parts had been missing in their Islamic history.[4133]

The coloniser, thus, as Fontana points out, saw himself as a missionary of new times who proposed 'to teach primitive peoples the true path of intellectual and material progress.'[4134] This view was shared by the communists. Engels writing in 1848, stated that:

> 'The French victory over Emir Abd el Kader (in Algeria) was finally a good thing for the progress of civilisation, as the Bedouin are barbarous thieves preying on the sedentary populations, whose supposed noble liberty can only appear admirable from the distance'[4135]

From the Western communist perspective, Rodinson wrote, 'the Muslims remained culturally backward because of the strength of fanaticism intrinsic to Islam.'[4136] And to achieve the enlightenment of Islamic societies, which might take some time, though, 'the revolutionary role, in Muslim countries,' had to belong to the European elite.[4137] Shaler, thus, writes:

> 'True civilisation can only come from a transfer of responsibility to Christian nations which would develop agriculture, industry and commerce and thus civilise the region. The 'primitive' (Muslim) was incapable of progressing alone.'[4138]

Abbe Raynal, equally, saw that the North Africans could not civilise themselves, and so ought to be taken in hand by the Europeans.[4139] The 'Algerines (Algerians), for instance, were committed by religion, custom and heredity to see life from a particular viewpoint,' and they would never

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[4130] *Bulletin*: Pays Independant: Maroc; XIV 1; January 1904; p. 23.
[4131] A. Moulieras: *Le Maroc Inconnu;* op cit; p. 23.
[4132] M. Garcia Arenal: Historiens; op cit; p. 691.
[4133] A. Dariac in his preface to J. du Tallis *(Le Nouveau Maroc*; Paris; 1923).
[4134] J. Fontana: *The Distorted Past* (Blackwell, 1995), p.130.
[4135] Quoted by W. Bouzar: *Le Mouvement et la Pause* (Algiers; 1983), vol 1; pp 216-7.
[4136] M. Rodinson: *Europe and the Mystique of Islam*; trans: R. Veinus (I.B. Tauris and Co Ltd; London; 1988), p.74.
[4137] Ibid.
[4138] W. Shaller: *Sketches of Algiers* (Boston; 1826), p.56.
[4139] Abbe Raynal: *Histoire philosophique et politique des etablissements et du commerce des Europeans dans l'Afrique* (Paris; 1826)

become civilised unless forced to do so; thus total conquest and permanent occupation were the only solutions.[4140]

> 'Political domination and economic exploitation needed the cosmetic cant of *mission civilisatrice* to seem fully commendatory' [Kabbani explains]. 'The image of the European coloniser had to remain an honourable one: he did not come as exploiter, but as enlightener. He was not seeking mere profit, but was fulfilling his duty to his maker and his sovereign, whilst aiding those less fortunate to rise toward his lofty level. This was the white man's burden, that reputable colonial *malaise*, that sanctioned the subjugating of entire continents.'[4141]

Colonisation was far from being the humane action of its apologists, though. The French, following their arrival in Algeria, slaughtered hundreds of thousands of people, and devastated towns, cities, crops, and livestock, besides looting wealth and property.[4142] An official report, for instance, stated:

> 'We have tortured people just on suspecting them; we have desecrated tombs, and temples and houses; have robbed people of their wealth, have massacred people carrying safe conducts, slaughtered whole populations, who were guilty of nothing; have tried local leaders because they dared oppose us, have imprisoned tribal leaders, have decorated dishonest intermediaries, turned shameful acts into diplomacy... in words have beaten in barbarism barbarians we had come to civilise.'[4143]

But writing to the Minister of war, Soult, the commanding officer of the French army, General Bugeaud held:

> 'That rigorous methods had to be applied to submit the country, without which there would be no colonisation, administration, or civilisation.'[4144]

A century on, at the height of the war of independence (1954-1962), in which over a million Algerians were slain, Albert Camus held:

> 'An Algeria constituted of federated settlements and tied to France seems to me preferable, without any possible comparison to simple justice, to an Algeria tied to an empire of Islam which

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[4140] Perkins and Douglas Morris: *Gunfire in Barbary* (Havant; 1982), p. 175.
[4141] R. Kabbani: *Europe's Myths*; op cit; p.6.
[4142] C. Ageron: *Modern Algeria*, trans by M. Brett, Hurst and Company (London, 9th edition, 1990), p. 11.
[4143] *Proces Verbaux et rapports de la commission nommee par le roi le 7 Juillet 1833* (Paris, 1834).
[4144] H Alleg et al: *La Guerre d'Algerie*: (Temps Actuels, Paris, 1981), p.66 and p. 69.

would only bring about an increase of misery and suffering and uproot the French people of Algeria from their native land.'[4145]

The same feeling is expressed with regard to the English destruction of traditional Indian society. Marx and Engels held that:

> 'Now, sickening as it must be to human feeling to witness those myriads of industrious patriarchal and inoffensive social organizations disorganized and dissolved into their units, thrown into a sea of woes, and their individual members losing at the same time their ancient form of civilization and their hereditary means of subsistence, we must not forget that these idyllic village communities, inoffensive though they may appear, had always been the solid foundation of oriental despotism and that they restrained the human mind in the smallest possible compass, enslaving it beneath the traditional rules, depriving it of all grandeur and historical energies.'[4146]

England's colonisation of India had, thus, a double mission:

> 'One destructive, the other regenerating-the annihilation of the Asiatic society and the laying of the material foundation of Western society in Asia.'[4147]

Thus, in order to justify both colonisation and its 'rigorous methods,' it was necessary to depict Muslims and Islamic society as barbaric, and their faith as the fundamental reason for such a condition. Hence, the 19th century twin approach in removing or curtailing the Islamic role in the rise of science and civilisation as noted by Joseph above, and in the generalised unfavourable depiction of Muslim society as amply noted, and as can be found in countless other works.[4148]

Independence from colonisation eventually took place in the mid 20th century; but, as Chejne explains, cliches have changed, of course, but the basic attitude remains the same:

[4145] A. Camus, in M. Alloula: *The Colonial Harem* (Manchester University Press; 1986), p. xii.
[4146] E. Said: Orientalism; p. 153. in Z. Sardar-M.W. Davies: *Distorted Imagination;* op cit; p. 60.
[4147] Ibid.
[4148] Such as A. W. Kinglake: *Eothen;* London (W, Blackwood; 1904).
M. Twain: *Travelling With the Innocents Abroad*; ed. D.M. Mc. Keithan (Oklahama Press; 1958).
Bayard Taylor: *Lands of the Saracens* (New York; Putnam; 1855).

> 'As in medieval times, whether referred to as Muslim, Arab, Saracen or Moro, he is a member of a degraded race. Unfortunately, this has affected Western judgement and led to ambivalence, and to unwillingness to acknowledge any merit in the Muslim's past or present.'[4149]

Equally Rosenthal observes how:

> 'An unfounded feeling of superiority also often distorts Western opinion concerning Muslim scholarship. It is strange, for instance, to hear a European scholar state in connection with Yaqut's rejection of the story of the Magic Horseman in Baghdad that 'it is seldom that Yaqut shows so much common sense,'[4150] when not withstanding his merits, this scholar is dwarfed into insignificance by Yaqut.'[4151]

These derogatory impressions of the Muslims and their civilisation are found to this day in countless works, as amply noted already in the previous parts; derogatory views which insist that Islamic science is a mere plagiarism of Greek science; that Islamic cities are mere chaotic urban masses; that Muslim military victories were accomplished against weakened, small armies, etc. Countless figures, not to say the near totality, of Western scholarship, media and all spheres of culture and politics, also daily still depict Muslims, their faith and culture in forms not much better than the worst of the medieval depictions seen above. Thus, to conclude with Vitkus:

> 'Unfortunately, the demonisation of Islam and misunderstanding of Islamic society and religion that this essay recounts are still prevalent in the dominant ideology of the West. Today, many of the stereotypes described above continue to shape the image of Islam produced by the mass media in North America, Europe, and other parts of the world.[4152] If we examine, in particular, the American representation of Islam in mass media journalism during the last 10-15 years, we will find ample evidence for an unbroken tradition depicting Islamic people as violent, cruel, wrathful, lustful, and so on. With the end of the Cold War, America needed a new ideological bogey man to serve as an alleged external threat; and perhaps this explains the recent

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[4149] A Chejne: The Role of al-Andalus in the movement of ideas between Islam and the West, In *Islam and the Medieval West*, K. Semaan Ed (State University of New York Press/Albany, 1980), pp 110-33: p. 117.
[4150] G. Le Strange: *Baghdad During the Abbasid Caliphate* (Oxford; 1901; 1923), 31; n. 1.
[4151] F. Rosenthal: The Technique and Approach of Muslim Scholarship; *Analecta Orientalia;* 24; Roma; 1947. p. 4.
[4152] See J. Esposito: *The Islamic Threat: Myth and Reality* (Oxford; 1992).

resurgence of anti Islamic imagery, a revival that draws upon a venerable tradition of anti Islamic demonisation that began in the medieval period and acquired some of its present features in the 16th and 17th centuries.'[4153]

This is anti Islamic imagery that reinforces the Western view that Islam caused the decline of Islamic civilisation, an issue to which this work now devotes the largest focus, for no author has ever seriously challenged this Western view.

[4153] D.J. Vitkus: Early Modern Orientalism; op cit; p. 226.

Two

ISLAM, SCIENCE AND CIVILISATION
(Between Assumptions and Truth)

The following chapter looks at the notion that Islam, as a faith, has caused the collapse of Islamic civilisation. It shows how, generally, with the rarest of exceptions, Western scholars on Islamic civilisation, even its most ardent defenders, are in agreement in blaming the decline of such Islamic civilisation on Islam as a faith, and on its 'Orthodox' branch, that is Sunni Islam, in particular. In seeking to prove this theory, such 'scholars' scarcely hesitate to bend historical facts and truths about the faith of Islam. Their theories are fundamentally contradicted by historical facts. For instance, they blame Islam for persecuting scholars, when the very reverse took place, the mosque, for instance, being the first school and university in Islam. They blame Islam for being an obstacle to learning, when the very foundation of Islamic learning was to resolve the practical demands of the faith. And much more will be considered.

This chapter will first show how such a practice of placing the blame on Islam has been pursued and institutionalised by almost all Western scholarship. Gatherings of experts on Islam are organised and books are written not to discuss the real reasons of Islamic decline, but instead to 'demonstrate' how Islam caused this decline. One such gathering and the fairly recent work by T. Huff's *Rise of Early Modern Science* highlight this issue.

The second part of this chapter refutes the main arguments made against Islam, its supposed cause of backwardness and decline, and shows how Western historians, once more, use distortions to make their case.

This chapter concludes by refuting the notion that Sunni 'Orthodoxy,' and its main proponents: Turks and Berbers, the 'Betes noires' of Western scholarship, were the main culprits behind Islamic decline.

1. Instances of Assumptions in:

a. *Classicisme et Declin Culturel dans l'Histoire de l'Islam:*[4154]

This is a published work, bringing together communications made at an international symposium on Muslim civilisation held in the French city of Bordeaux on 25-9 June 1956. It highlights many of the matters under discussion here. At this gathering, a crowd of illustrious names such as Schacht, Terrasse, Hartner, Cahen, Bousquet, Pellat, concluded unanimously that the end of Islamic civilisation was due to Islam as a faith and to the so called Islamic Orthodoxy, in particular. All that was left for each one of them, from his corner, in his own particular subject, was to find the explanations to support this theory, because the object of such gathering was to explain the fault of Islam in the decline (not to discuss the decline of Islamic civilisation,) the conclusion was reached even before the discussion. This meant all the experts had to bend the facts to back this theory, and they had to set aside whole chunks of history, which makes it very easy for any of their critics to demolish their whole argument. Focus here is on one particular communication that sums up the problems under discussion here: Ritter's: 'L'Orthodoxie a t'elle une part dans la Decadence?'(Did Orthodoxy Play a Part in the Decadence). Before looking at Ritter, first, though, a brief outline on the main deficiencies of this symposium.

The major deficiency of this symposium, like others of the same nature, was that the focus was in finding possible explanations in Islam which caused the decline of its civilisation, and in setting aside every other possible reason. Hence, not one single author, or a single essay, looked at the possibility that Muslim civilisation could have declined due to external

[4154] R. Brunschvig and G.E. Von Grunebaum: *Classicisme et Declin Culturel dans l'Histoire de l'Islam;* Actes du Symposium International d'Histoire de la Civilisation Musulmane; Bordeaux 25-29 June 1956; Editions (Besson-Chantemerle; Paris; 1957).

invasions, destruction and loss of its major centres of civilisation: Baghdad, Damascus, Aleppo, Cordova, Seville, Valencia, Bukhara, Merw, Khwarizm, etc, (all taking place in the 13th century). The only time one author, Hartner, touched on the issue, it was, in fact, to praise the Mongol invasion! He even goes as far as saying:

> 'In the east, there is a revival of science thanks to Hulagu, the last revival of sciences under a ruler who was stranger to religious prejudice, and whose ambition was to give back the splendour to Arabic science, whilst his brother Qubilai sought to do the same for Chinese science.'[4155]

Hartner is of course grossly distorting the facts, for Hulagu and the Mongols rather than being promoters of science were, with the crusaders and other invaders, responsible for its extinction in the Muslim world, as the following chapter will amply show. The Mongols, under Genghis Khan, first, during the years 1219-1221, and then under Hulagu, in the 1250s, exterminated millions of Muslims in the space of a few decades: 1.3 million in Merw and other eastern parts, 800,000 in Baghdad, for instance.[4156] They also burned libraries, destroyed colleges, and slew scholars.[4157] Islam never recovered from the Mongol invasions. Hartner bases his theory on the fact that Hulagu promoted the scientist Nasr Eddin al-Tusi. In truth, Al-Tusi was Hulagu's astrologer, and it was he who read the stars and directed Hulagu's campaign in accordance with what the stars said.[4158] It was Al-Tusi who convinced Hulagu to invade and destroy Baghdad in response to star signs.[4159] Hulagu's subsequent construction of an observatory for Al-Tusi at Maragha had purely astrological purposes, never meant to promote any science. Moreover, Hulagu's hatred of Islam and Muslims was legendary, his aim being the extinction of the whole Muslim entity.[4160] His wife was a Christian, and so were the wives of other Mongol generals, , themselves also Christians, who had formed an alliance with the crusaders to wipe out Islam.[4161] The reason, in fact, why

[4155] W. Hartner: Quand et comment s'est arête l'Essor de la culture dans l'Islam; in *Classicisme et Declin; op cit* pp. 319-37, at p. 332.
[4156] E.G. Browne: *Literary History of Persia* (Cambridge University Press; 1929), 3 Vols; Vol 2; p. 439; H.H. Howorth: *History of the Mongols* (London, 1927); Sir Thomas W. Arnold: Muslim Civilisation; op cit; p.279.
[4157] Ibid.
[4158] Baron G. d'Ohsson: *Histoire des Mongols*; p.225 ff.
[4159] Ibid; pp. 225-6.
[4160] A. Mieli: *La Science Arabe;* op cit; p.147.
G. Sarton: *Introduction;* Vol II; op cit; p.37.
[4161] See, for instance, how this alliance between crusaders and Mongols was built in: J.J. Saunders: *The History of the Mongol Conquests* (Routlege & Kegan Paul; London; 1971).

subsequently Hulagu came into conflict with the Golden Horde (the northern Mongols commanded by Berke) was precisely because of their opposition to the bloody manner in which Hulagu had dealt with Islam and Muslims.[4162]

Another communication, by Abel, blames the decline of Islamic civilisation on occult practice in the faith of Islam, especially in the 12th – 13th century.[4163] Thus, he says:

> 'In the case of Islam, it was very obvious that the practice of magic, witchcraft, the art of divination, and talismans occurred during the time, precisely when the decline manifests itself in the field of creative knowledge, social organisation, economic life, and most of all, in the efficiency of religious thought.'[4164]

Abel supports his views by chosen extracts from the Qur'an, which warn against occult practice, and cites an author of the late 12th -early 13th century, al-Buni, to prove his theory, which is untenable. Islam never condoned in one way or another occult practice. Such practice is denounced in the Qur'an, by the Prophet, and all Islamic scholarship. If Islam had condoned occult practice, why didn't it manifest itself in all the centuries prior to the 12th-13th century. As for that figure, Al-Buni, mentioned by Abel, he had no influence of any sort on the history or civilisation of Islam; no Islamic source gives him any credit of any worth. In fact, Al-Buni only finds a good place in Abel's writing.

We turn focus now to Ritter's essay: *L'Orthodoxie a t'elle une part dans la Decadence*? (Did Orthodoxy Play a Part in the Decadence),[4165] which outlines the means by which, supposedly, Islamic Orthodoxy (Sunni Islam) caused the decline of Muslim civilisation. Ritter first lashes out at Al-Ghazali, the 'orthodox in chief' (pp.167-8), as summed up here:

> 'In an answer to a letter from a student asking him what were the important sciences, al-Ghazali advised him to avoid the poetry of al-Mutannabi and al-Buhtury, which amount to time wasting, but advised the student to learn about the sciences of the Islamic schools of jurisprudence, medicine, poetry, astronomy, prosody,

H.H. Howorth: *History of the Mongols* (London, 1927).

[4162] B Spuler: *Les Mongols dans l'Histoire* (Payot, Paris, 1961); H.H. Howorth: *History of the Mongols; op cit;* Baron G. d'Ohsson: *Histoire des Mongols*; op cit. etc

[4163] A. Abel: La Place des Sciences occultes dans la Decadence; in *Classicisme et Declin;* pp. 291-318.

[4164] Ibid; pp. 291-2.

[4165] H. Ritter: L'Orthodoxie a t'elle une part dans la Decadence? In *Classicisme et Declin Culturel*. pp. 167-81.

> and so on. To another student, he said that he should only study the sciences he would if he only had a week to live. In other words, in Orthodox Islam, only the sciences which prepare one for the life after death are useful. Sciences ought not be studied for their own sake. The student should not learn too much, only learn enough of what is necessary for the faith, and prepare himself for after death.'

These recommendations to students, Ritter concludes, symbolise the decline of intellectual activity by the renouncing of life, and in favour of the after life only. And so intellectual life died in Islam because Al-Ghazali killed original philosophical debate.

Ritter's attack on Al-Ghazali is shared by all Western historians, and it will be amply refuted further on. It is necessary, though, to answer Ritter here, albeit briefly. Ritter, first chose to ignore how Al-Ghazali advises the student to read medicine, astronomy, and 'so on'. How could someone reading these sciences be fatalistic, and renounce life? Secondly, Ritter, just like his colleagues, picks on one limited criticism, to generalise it to suit his views. This is reminiscent of some instances seen before, whereby the attack on alchemy, for instance, was used by Western scholars as evidence of Islamic hostile attitudes to both chemistry and the experimental method. Ritter uses Al-Ghazali's attacks on some form of poetry and philosophy to widen it to an attack on sciences and scholarship. This is wholly fallacious, for no person familiar with his works can find that Al-Ghazali, at any point in his life, attacked scientific work. He himself was the author of scientific treatises, including, *Talkhis al-haya* (Concise Exposition of Astronomy (manuscript known to be in Paris in 1217, but lost today), and *Fi harakat wa tabiat al-Kawakib* (On the Motion and Nature of the Planets).[4166] Ritter also distorts the picture gravely, for he uses Al-Ghazali's attack on a form of poetry and philosophy to widen it to the notion that Sunni Islam is hostile to sciences, forgetting that the thousands of scholars in Islam were predominantly Sunni. Ritter, thus, by picking on narrow instances, and generalising them to justify his theory, ends up making gross distortions, wholly contradicted by facts.

Ritter turns his attention to Islam, first focusing (pp.170-1) on Islamic 'fatalism.' He explains that because people's fate has already been decided, and that any ill deed might cause them to go to hell, any good work is doomed in Islam. 'From this doctrine of predestination no impulse towards secular achievements can develop,' he says. This issue of fatalism

[4166] B. Rosenfeld and E. Ihsanoglu: *Mathematicians*,op cit; p. 167.

in Islam will also be amply debated further on. But here, briefly, if we look at all the accomplishments of Muslims in sciences, in building hospitals, setting up observatories, building schools, erecting gardens, and so on and so forth, it contradicts the picture of a fatalistic nation only awaiting death. Ritter is also mistaken about Islam because repeatedly the Qur'an associates the practice of faith with performing good deeds as the price for a place in heaven.

On p. 171, Ritter says that Islam hinders accomplishments because of:

> 'The many demands of the faith. Individuals are so much absorbed in accomplishing such religious rituals that in the end they have no time or place for anything else. Religious obligations also focus on determined requirements: prayers, fasting, etc. thus, nothing else is accomplished as part of such religious duty.'

This is false again for any person can see Muslims pursuing active and professional lives besides observing their religious duties. And again, Islam does not just reward observance of the faith, it also demands and rewards good deeds whatever their scope, or nature.

Ritter, however, notes in p.171:

> 'That it is true that besides religious duty it is also advised *amal salih* (good work) but this good work is hampered by the fact that in the world of business and trade it is also taught that the devil plants his flag in the market: that the devil is the master of the market.'

This, again, is a gross distortion. The Qur'an, as seen in the first part above encourages trade and trading. Also, according to the Prophet's tradition, trade is a superior way of earning one's livelihood:

> 'If you profit by doing what is permitted, thy deed is a *jihad* (that is, is identified with holy war or any vigorous effort undertaken for God's cause) and, if you use it for your family, and kindred, this will be *sadaqa* (that is, a pious work of charity); and truly, a *dirhem* (drachma, silver coin) lawfully gained from trade is worth more than ten *dirhems* gained in any other way.'[4167]

This attitude was shared by the early Caliphs of Islam; Omar (Caliph 634-44) was reported as saying:

> 'Death can come upon me nowhere more pleasantly than where I am engaged in business in the market, buying and selling on behalf of my family.'[4168]

[4167] Zahid Ibn Ali: *Corpus iuris....* Ed. E. Griffini (Milan; Hoepli; 1919), No 539.
[4168] M. Rodinson: *Islam and Capitalism;* op cit; p. 17.

The first part of this work has also abundantly shown the trading and business enterprise of Muslims, who surpassed every other entity in establishing trade networks which went from Scandinavia as far as China, passing by Africa, the rest of Europe and the Middle East. And who was the first and most important trader in the Islamic era? The Prophet, of course. Thus, for Ritter to hold such a view that Islam hampers trade is beyond ridicule. The restrictions Islam places on trading are some which involve trade in certain items such as wine, pigs, animals that have died otherwise than by ritual slaughter, or in goods that are considered to be common to every one: water, pasture, fire.[4169]

Ritter (p.172) holds that:

> 'In Islam, God is responsible for the events of history and politics. Thus, when a ruler takes power, the Muslim believer submits. The Muslim must also pray behind the Imam whether the latter is pious or full of vices. This results in killing the impulse within Muslims to alter their condition and change things. However, whilst he does not act on politics, still due to the concept of Jihad, the Muslim is responsible for so many wars. It is because of Jihad that there has not been any peace between Muslims and non-Muslims.'

Again, here, we have many fallacies in such a short space. No entity rebelled against the unjust ruler as much as Islam, and to this very day as is obvious around us. And there is no such a thing as Muslims being enjoined to tolerate injustice, the Qur'an, in fact is full of summons preaching the reverse. Ritter is telling a fallacy when he says that Muslims pray willingly behind the corrupt imam. Prayer in Islam, he should know, is considered void if performed behind the corrupt person. As for wars between Muslims and others (crusades, colonisation...), they were not the consequence of Islamic fervour for war, rather, the reverse: Jihad was called as a response to the invading crusaders and Western colonisers. To this day, as any person can see, it is not Islamic armies occupying Christian soil, but the reverse. Jihad is called precisely to answer the invader of the Islamic land.

On p.173, Ritter says:

> 'The believer, in Islam, is enjoined not to admire a beautiful tree because admiration is only for God the Creator. Thus it killed poetry. Poetry which glorifies wine drinking, and the love for the pretty ones, is banned in Islam.'

[4169] D. Santillana quoted by M. Rodinson: *Islam and Capitalism;* op cit; p. 17.

Of course there are banned things in Islam. But to say Islam forbids the admiration of beauty is another fallacy. Ritter only needed to look at Islamic gardens, Islamic art and beautiful buildings to realise what a stupid comment he makes.

On p.175, he writes:

> 'It is God who is responsible for all that happens around us. Hence natural sciences are forbidden in Islam because they give humans the power to understand what is the prerogative of God alone.'

Which is false for, as shown in the previous part, Islam gave rise to hundreds of natural scientists.

Ritter corrects himself on this matter a few pages down (p. 178):

> 'There have been, it must be said, many natural scientists, mathematicians, and astronomers, but who have only transmitted Classical learning. And we must remember that in classical Islam all scientists were not orthodox; and many were pagans or Christians. Orthodoxy was against these people.'

Which is again false, for any look at the names of such scientists, in general, will show their Islamic origin. And any study of their work will show how they all begin with the expression: 'In the name of God, The Merciful and Compassionate.' As for Muslim scientists only transmitting Classical learning, this has been amply demonstrated not to be the case: any first year student can pick any Islamic work they wish and compare it with any Greek counterpart, to realise how inane Ritter's, and similar comments by others, are.

Ritter (p.178) seems to admire the vast accomplishments of Muslim scholars:

> 'We must note the huge works such as the eighty volumes of Ibn al-Asakir: *Tarikh Dimashq*; or the works of Al-Tabari and Al-Ghazali equally huge in size.' However, these gigantic accomplishments, he says, are due 'to the marvellous Arabic writing which can be written five times faster than Latin script.'

Thus, accomplishments not owed to the merit of the scholars, but simply to the practicality of their language.

The final defect of Islam according to Ritter (p. 179):

> 'The domain of religion in Islam has remained untouched. It has been cut off from modern reason and rational criticism, which has left the Koran free of criticism.'

This is a common form of attack on Islam by Westerners, who generally tend to assimilate the Islamic experience with that of the West, never accepting that such experiences were totally different. As explained above, Islamic civilisation rose with the faith, in the 7th century, and declined when the political power of the faith declined, in the 13th century. This is the primary reason why nobody for centuries seeking to refute Islam or the Qur'an on such basis has managed anything credible or sustainable.

b. T. Huff's *The Rise of Early Modern Science:*[4170]

This is one of the more recent works continuing the established tradition of blaming the decline of Islamic civilisation on Islam, and Sunni 'Orthodoxy' most particularly. In seeking to do this, Huff follows the manner adopted by most works, which is praise for aspects of Islamic civilisation accompanied by criticism of the faith of Islam. His other technique is in demeaning the Islamic contribution as much as he can. These aspects are looked at through a number of extracts, and are refuted.

First, Huff seeks to show that Islamic accomplishments belong to Greece. Thus, (in pp. 48-9) He writes:

> 'Our concern is with the fact that from the eighth century to the end of the fourteenth, Arabic science was probably the most advanced science in the world, greatly surpassing the West and China. In virtually every field of endeavour-in astronomy, alchemy, mathematics, medicine, optics, and so forth-Arabic scientists.... were in the forefront of scientific advance. The facts, theories and scientific speculations contained in their treatises were the most advanced to be had anywhere in the world...'

The chief reason for this, Huff says was the Muslims' full access to the Greek heritage, and their translation of 'The great works of the Greeks' in particular, whilst the Chinese were cut off from such heritage. On p. 50, he says 'the defect of Chinese mathematical thought was that it lacked the logic of proof, Euclid's elements of geometry, and Ptolemy's planetary models...' Which contradicts what he had said before (p.48,) in recognising the vast Chinese contribution to science. He pursues the argument (p. 51,) stating that in optics, which in early science, probably

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[4170] T.E. Huff: *The Rise of Early Modern Science* (Cambridge University Press, 1993).

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[4170] T.E. Huff: *The Rise of Early Modern Science* (Cambridge University Press, 1993).

played the same role as physics in modern science, the Chinese, he quotes Needham:[4171]

> 'Never equalled the highest level attained by the Islamic students of light such as Ibn al-Haytham', and one of the main reasons was that the Chinese were 'greatly hampered by the lack of the Greek deductive geometry' that the Arabs had inherited.'[4172]

Hence, to sum up his thoughts, the Muslims succeeded because they followed the Greeks, whilst the Chinese failed because they did not.

If Huff looked at sciences, he would find that all Islamic sciences evolved in a considerably different manner from Greek science. Greek scholars were also constantly refuted. Furthermore, some sciences, such as civil engineering, agriculture, nautical sciences and instruments, most construction techniques, trade and commerce, have absolutely no Greek link of any sort, and yet they were some of the greatest achievements of Islamic science and civilisation. Thus, his argument that Islamic achievements mirror those of the Greeks is to say the least: ridiculous. Besides, many of the Muslim breakthroughs, as seen in the previous chapters, were taken from China and India. And it is very easy for anyone to challenge Huff's and similar arguments by simply looking at Islamic science and measuring the minute proportion Greek science occupies in such Islamic science.

Huff, who is more than willing to find a Greek influence in every Islamic achievement, refrains from adopting the same approach in tracing Islamic influences on subsequent Western ones, as in the instance of Copernicus heavy borrowing from Ibn al-Shatir and other Muslim astronomers. Huff himself recognises that Copernicus' work relied heavily on his Muslim predecessors (pp. 54-6). He even (p. 54) quotes Swerdlow who says 'not whether, but when, where, and in what form' Copernicus learned of the Maragha theory.[4173] However (p. 57, footnote 41) he says:

> 'Given the present absence of any documentary evidence connecting Ibn Shatir and the work of the Maragha school of Astronomers to Copernicus, it is entirely possible that the ''Tusi couple" and the other innovations found in Copernicus's work were independently discovered by Copernicus. This would then be another illustration of the sociological thesis of the simultaneous, independent and multiple discovery of scientific innovations.'

[4171] J. Needham: *Science and Civilization in China*; 7 vols. (Cambridge University Press, 1954 ff.).

[4172] Ibid, 4:xxiii.

[4173] N Swerdlow and O Neugebauer, *Mathematical Astronomy in Copernicus's ''De revolutionibus''* (New York: Springer Verlag, 1984), p. 46. Some of the conclusions are: Copernicus planetary models for longitudes in the *Commentariolus* are based on those of Ibn al Shatir, while those of the superior planets in *De revolutionibus* use Maragha (in Western Iran) models. D.R. Hill: *Islamic Science*, op cit, p. 46, gives a detailed explanation of how Copernicus might have used his Muslim predecessors' works.

Huff first contradicts what he had said previously. Secondly, he fails to notice that between the Muslim discoveries and Copernicus, centuries had elapsed, and in such centuries Muslim knowledge could easily have found its way to Copernicus following patterns seen with other sciences and discoveries. He also fails to notice the similarities between Copernicus' planet theories and his Islamic predecessors. He fails also to take notice of the powerful evidence provided by other scholars as seen in the previous part on the chapter on astronomy.

(Page 150,) however, he concedes with respect to Copernicus, stating 'the very models worked out by the Maragha school of the thirteenth and fourteenth centuries were eventually used by Copernicus,' but only to attack the Muslims on another front: stating that:

> 'The breakthrough to modern astronomy was, paradoxically, mathematically worked out by the Arabs, yet unobtainable for them, because of their failure to make the metaphysical leap, that is to place the same mathematical models in the new heliocentric framework Copernicus dared to suggest. Arabic science did not achieve this accomplishment and, in fact, went into a state of decline.'

He returns (pp. 179-80,) to the Maragha observatory, again recognising its great achievements, huge library and unique instruments, before crudely dismissing it as a brief manifestation that lasted no more than half a century, which is false, when considering that observation in Islam began in the late 8th century, and lasted until the 15th century (Samarqand), and went on in India under the Mughals, and that Islamic observation relied on large instruments, especially from the 9th century onwards, and also relied on techniques and organisation, all subsequently adopted by the Christian West.[4174]

Huff, turns his attention to Islam. He states (pp 52-3,) that 'considered altogether, in mathematics, astronomy, optics, physics, and medicine, Arabic science was the most advanced in the world.' However, he asks himself, why didn't Arabic science give rise to modern science (as if all the science of al-Khwarizmi, Ibn Sina, Al-Biruni, and the hundreds of others, as seen in the previous chapter, and whom he himself admits gave

[4174] L. Sedillot: *Memoire sur les instruments astronomique des Arabes*, op cit.

rise to modern civilisation was not modern enough;) and why did it go into decline beginning in the 12th century.[4175] Referring to Armand Abel,[4176] he gives the answer: Islam:

> 'A common formulation of the negative influence of religious forces on scientific advance suggests that the twelfth and thirteenth centuries witnessed the rise of mysticism as a social movement. This in turn spawned religious intolerance, especially for the natural sciences and the substitution of the pursuit of the occult sciences in place of the study of the Greek and rational sciences.'

Huff is distorting facts, for he is referring to a decline that did take place in the (13th century), but not due to the causes he suggests, but to causes which will be looked at further on. Briefly here, though, it is not magic which caused the decline of Islamic science, for Islam strictly forbids magic and all forms of occult sciences as totally un-Islamic. Where Huff finds his evidence of an Islam that promotes occult sciences must be in a copy of the Qur'an he, and those with similar opinion, alone, have at their disposal.

Huff savages the Islamic system of education (as in p. 61) by pursuing the same technique of praising something before unleashing his attack on Islam. Hence, he rises in defence of Muslim civilisation, attacking the likes of Ben David, who in '*The Scientist's Role in Society*' said nothing about the Muslim contributions 'when it has long been recognised that the translation of Arabic works in the twelfth and thirteenth centuries was 'a major galvanising force triggering the unparalleled study in medieval European universities.' However, at the bottom of the page (note 48), he states that the European universities were unique to world civilisation because they embraced the Greek philosophical tradition and sciences, which were barred in Muslim colleges. Further on (p.187), he states that universities developed in Europe and achieved the scientific breakthrough because, amongst other things, the works of Ibn Sina, al-Khwarizmi, Euclid, Ibn al-Haytham etc, were not, in his words 'taught secretly, surreptitiously, or in the privacy of an individual's home as in the Islamic world. Nor did they have to be taught in the guise of religious traditions derived from the Scriptures.' He continues his attacks on the madrasas,

[4175] Chief amongst these is Ernest Renan: *Discours et Conference* (Paris, Calman Levy, 1919). To him racial factors and Islam are to blame. Whilst hostile to Islam and Muslims, Renan and his followers, still care to emphasise that their intentions are for the best of Muslims.
[4176] A. Abel: ''La Place des sciences occultes; op cit; quoted by Huff.

> 'Which failed to teach the sciences of the ancients', [p 153, stating]: 'perhaps surprisingly, books containing the wisdom of the natural sciences were allowed in the libraries of the madrassa as well as many mosques,' but he adds 'the prohibition regarding the natural sciences chiefly applied to teaching them.'

Hence, if one understands him correctly: it was right to have the wrong books stored in libraries of the madrasas and mosques, but wrong to use them, and, if he is to be believed, the whole flowering of Muslim science proceeded against a background of repression, whereby books were burnt, and people taught foreign sciences under the ruse of teaching hadith. Hence, the Muslims who are urged by their religion to learn, including the foreign sciences, who 'preserved the whole Greek heritage,' who 'copied Greek science', who had libraries with hundreds of thousands of volumes each, who dominated sciences for centuries, all facts which he himself had acknowledged above, now, these Muslims become book burners, hunting down transgressors who learned foreign science in hiding.

Huff, in fact, attributes achievements in Islamic learning (p. 154) to:

> 'Loopholes in the madrasa system [which] account for the fact that Arabic science achieved great heights in medicine, optics, mathematics, and astronomy. The philosophical and natural sciences were intentionally excluded from the madrasa, but they were often present sub rosa.'

And he continues (p. 155):

> 'The problem was, however, that anyone who gained a reputation for excellence in the Greek sciences became an easy target of the traditionalists who could simply issue a fatwa- a legal ruling- condemning that person and his studies.'

This final assertion is remarkable, made not just by Huff but also by countless others. They assert it, yet cannot offer a single name of a Muslim scientist who had been sent to the stake or executed for his ideas or writing. And this is at a time, when the likes of Jabir, Ibn Rushd and al-Masudi held views that could have, without a shadow of a doubt, cost them their lives elsewhere. Nobody was ever burnt in the land of Islam, whether scholar, witch or sorcerer, because Islam forbids the burning of humans. As for the madrasa, it was a creation of the 11th century (1067), so, which loopholes is he speaking about to explain the burst of scholars such as Al-Kindi, Al-Farabi, Al-Khwarizmi, Jabir Ibn Hayan, Ibn Firnas, etc… who all lived centuries before the madrasa appeared?

Further on (p. 170), Huff admits:

> 'To some degree the teaching of medicine escaped the prohibition against the teaching of the natural science in quasi public institution... Medical texts were taught and discussed in a majlis,

> a discussion room attached to a hospital,' and that 'there are also some rare reports of medical madrasas being established.'

Thus, contrary to what he had said above, some madrasas at least taught science after all, and had Huff cared to research his subject more, he could have seen a highly organised and effective Muslim education system, including in hospitals, and scientific academies established for the purpose. Never mind higher learning organised and delivered in mosques (on which more later). Sabra also explains that the high level of scientific and mathematical sophistication achieved by Muslim scientists, and their output meant that their teaching of mathematics and neighbouring subjects, far from being elementary or scanty, was well organised and wide ranging:

> 'It is as though they had gone through a systematic course of study. A strong tradition of teaching the foreign sciences in Islam must have existed for many centuries, even though we do not know the full details of how it worked.'[4177]

Other Islamic achievements, such as paper manufacturing, books and libraries, are not free from Huff's criticism. Hence (p. 72), he praises Muslim manufacturing of paper, but quickly uses a quote by Pedersen,[4178] clearly out of context, to add: 'nevertheless, this art was soon taken over by the West.' Which is a gross distortion, for paper entered the land of Islam in the very late 8th century, spread throughout the 9th and 10th century, entered Spain, then Sicily, and only reached the Christian West in the 13th–14th century. Only in 1293 the first paper mill set up in Bologna.[4179] In 1309 was the first use of paper in England, and Germany in the late stages of the 14th century.[4180]

Huff does the same with respect to the Muslim libraries (pp. 73-4), praising their gigantic sizes (including millions of volumes,) and their luxury, order and organisation, accepting (p. 74) that comparatively the Sorbonne library of the University of Paris in the 14th century had a mere 2000 manuscripts, while the Vatican library in the 15th had 'a paltry' 2,257,[4181] before, just as he did previously, knocking down the Islamic achievement by adding:

[4177] A.I. Sabra, The Scientific Enterprise, op cit, p. 183.
[4178] J. Pedersen: *The Arabic Book,* op cit, p. 64.
[4179] D. Hunter: *Papermaking*; op cit; p.474.
[4180] T.K Derry and T.I Williams: *A Short History*; op cit; P. 232.
[4181] J F. D'Amico, 'Manuscripts,' in *The Cambridge History of Renaissance Philosophy*, ed. Charles Schmitt and Quentin Skinner (New York: Cambridge University Press, 1988), pp 11-24 at pp. 15 ff. D'Amico follows K. Christ, *The Handbook of Medieval Library History*, trans. T.M. Otto (London: Methuen, 1984).

> 'It sometimes occurred that those who were known to collect books and to have large libraries were suspected of being unorthodox, and their libraries were confiscated and destroyed.'

Actually, there are very few cases of private collections (less than ten instances counted by this author, in the whole history of Islam,) that were destroyed on the orders of despotic rulers (as there were and are in Islam), but the whole idea of the library, as amply shown in part one, was born in Islam. Huff sets aside the fact that, at all times, in all places, libraries thrived in Islam in their thousands, even within the very walls of the institution of Islam, the mosque (and not just religious books as will be further on amply shown). Besides, the burning of a few libraries and a number of books cannot be used as proof of Muslim hostility to books when it was the Muslims who began the mass production of books.[4182] Muslims also established and had the largest public libraries in history, open to all.[4183] Finally, the Muslims respect for books is unique in history.[4184] It was, as the following chapter shows, the crusaders and their allies, and later the Christians when they conquered Muslim lands who burnt Muslim libraries.

With respect to Muslim medical sciences, Huff adopts the same technique of praising accomplishments in the field to open the way to attacks on Islam. First, he praises Muslim hospitals (pp. 171-2) stating that 'it is with regard to its hospitals, that Islamic medical practice advanced beyond other cultures,' adding that hospitals had rooms equipped for orthopaedists, surgeons, physiologists etc, and had waiting rooms, pharmacists, nurses, administrators, discussion rooms for instruction, libraries, all the makings of the modern teaching hospital etc. Following the praise, he unleashes his attack (p. 172), saying that the hospitals were 'rigid institutions with precarious futures, because they were founded under the religious law of trusts that permitted no deviation from the original founder's stipulations.' 'Suggestions,' he adds, quoting Dols (a demeaner in chief of Islamic accomplishments),[4185] 'have also been made that the hospitals were largely for the poor and the incurable.' Then (p.

[4182] J. Pedersen: *The Arabic Book*; op cit.
[4183] O. Pinto: 'The Libraries of the Arabs; op cit.
R.S. Mackensen: Background; op cit.
Y. Eche: *Les Bibliotheques Arabes, Publiques et Semi Publiques en Mesopotamie, en Syrie et en Egypte au Moyen Age*. Damascus: Institut Francais. 1967
[4184] A. Shalaby: *History of Muslim Education* (Dar Al Kashaf; Beirut; 1954).
[4185] M. Dols, The Origins of the Islamic Hospital: myth and reality, *Bulletin of History of Medicine* 61, (1987) pp 367-90. (Huff gives page 31 for his note, which can only be wrong in view of the paging of the article).

174) he holds that Islam was a hindrance to the medical science, and that its standards were poor (p. 175). Then (in p.176,) he cites and praises the achievements of Muslim physicians especially Ibn al-Nafis and Ibn al-Quff, conceding that they were four hundred years ahead of Europe (p. 177), before rushing to add that these and others were 'a casualty of orthodox' Islam, as indeed, 'like the madrasas, the hospitals were religious endowments and therefore constrained by the religious law' (p.178). He then makes a full assault on Islam, stating that religion forbade dissection of human bodies (p. 178), and that it was widespread amongst 'pious Islamic believers' that illness was a punishment from God for evildoing on the part of the sick person' (p. 179).

On all these issues Huff is wrong. The previous part and chapter on medicine have shown the considerable number of Islamic medical breakthroughs, which deny Huff's assertions. As for Islamic hospitals, they served as an inspiration to modern hospitals. Huff is also wrong when he says that they were only open to the incurable, for these hospitals, in their constitution were open to all, and included schemes for covering people's needs after they recovered and left hospitals. He is also wrong when he says that people accepted their illness as a punishment from God, for the Prophet himself is reputed for saying that every disease had a cure. And had Muslims been as fatalistic as he claims, they would never have studied medicine, practised it, or built hospitals, but would, instead, have relied only on their saintly figures for cures, which was not the case at all as amply shown throughout this work.

To reinforce his argument that Islam was the cause behind the decline of Islamic science and civilisation, Huff brings us to Muslim society today, highlighting its backward, dire condition. To give his argument greater legitimacy he builds his argument around the views of some modern 'Muslim' scholarly figures. Thus, he says:

> 'As recently as the mid 1980s, concerned Muslim intellectuals lamented the fact that modern science had not taken root in the Islamic countries of the world, with the consequence that there is no Islamic Hong Kong, Singapore, or Japan.[4186] According to Abdus Salam, the president of the Third World Academy of Science, 'of all the people of this planet, science is weakest in the lands of Islam.'[4187] The reason given for this is that 'secular,'

[4186] S. Hussaini: Toward the rebirth and development of Shariyyah science and technology.' *MAAS Journal of Islamic Science*; I; No2; 1985; pp. 81-94; at p. 83.
[4187] As cited by P. Hoodbhoy: *Islam and Science: Religious Orthodoxy and the Battle for Rationality*; with a foreword by M. Abdus Salam (London; Zed Books Ltd; 1990), p. 28.

> Western and 'Eastern' science and technology have no basis in the Islamic ethos and Muslim culture. Their adoption makes Muslims less Islamic.[4188] More simply put, modern science is perceived as un-Islamic, and those who embrace it are thought to have taken a first and fatal step toward impiety. It was for this reason that like minded Muslims founded the Muslim Association for the Advancement of Science in 1985. According to these Muslims, all scientific ideas must be shown to be consistent with, if not derived from the Sharia.'[4189]

Whilst the reasons for the dire condition of Muslim society today are not the object of this work to discuss, Huff should know that with the exception of Iran, all Islamic countries have been ruled by secular, Westernised elites for decades now, and by Western powers for over a century before. Thus, chaos, mess, and backwardness are to be attributed to these Westernised elites and Western powers. He is ill advised to attribute this state of backwardness of Islamic society today to Islam, or to Islamic rule, when neither have had any say in the affairs of chaotic, backward Islamic societies for nearly the last two centuries.

The issue of the collapse of Islamic civilisation in the later Middle Ages will be amply looked at in the subsequent chapter, but brief points can be made here. In all his explanations, Huff ignores the most central element for the collapse of Muslim civilisation, which was the result of its systematic destruction in the 13th century. Indeed, in that century, and with the exception of Cairo, Islam lost all its centres of power and civilisation either permanently or to permanent devastation. Khwarizm, Nishapur, Herrat, Samarkand, Bukhara: all great centres of Islamic learning were reduced to rubble and their population entirely annihilated in the year 1219-1222 by the early Mongol invasions.[4190] Cordova (1236), Valencia (1238), Seville (1248), then the rest of Muslim Spain (Murcia, Jaen, Majorca, etc), with the exception of Grenada, were all lost to Islam for ever in those years. Baghdad (1258), Syria (Aleppo, Damascus, etc, in 1259-1260), were destroyed beyond recovery by the Mongols. These were the places where in excess of 90% of Islamic scholarship came from, resided or worked.[4191] Huff, like the majority of historians sets aside such losses. He ignores the

[4188] S. Hussaini: Toward the rebirth; op cit; p. 83.
[4189] T.E. Huff: *The Rise*; op cit; p. 235.
[4190] J.J. Saunders: *The History of the Mongol Conquests* (Routlege & Kegan Paul; London; 1971), p. 55-6.
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Mongol effect, yet as Browne saw it, the Mongol invasion of the 13th century inflicted on Islam a blow from which it has never recovered.[4192] Huff, like nearly every other modern historian, also sets aside the effects of the crusades, as if two centuries of killing and destruction (1096-1291) had no damaging effect on Islamic civilisation. Yet the rare studies on such a crusader impact uncover a trail of destruction, and, above all, a genocide that was unique in early history: populations such as those of Syria and Palestine, for instance, were nearly totally wiped out.[4193] Huff also holds that the orthodox exerted their powers in the 13th century. Yet, in fact, Al-Ghazali (b.1058-d.1111) and his band of orthodox were men of the 11th; Al-Ashari, another maligned Orthodox to be considered further on, is from an even earlier era (fl. 10th century). If these people had killed Islamic science, what, then, can explain the flourishing Islamic science of the 11th-early13th century period, most particularly in places that remained free from the crusader onslaught?

Huff is hardly alone in blaming Islam for the decline of Islamic civilisation. Hordes of similarly minded 'historians' have preceded and followed him. The following section considers how such 'scholars' build their arguments around specific matters, arguments which are then refuted.

2. Islam, Science and Civilisation:

In this section, the claim that Islam caused the decline of Islamic civilisation is dissected and refuted in its three main arguments:
-First, that Islam is antagonistic to science and learning in its very essence.
-Secondly, that Islam is a fatalistic faith and a faith of the occult.
-Thirdly that Islam is a persecuting agency of scholars and scholarship.
These elements are refuted, and then in the fourth point is shown how Islam, in fact, acted as a spur to the scientific advance of the 7th-13th century period.

[4192] E.G. Browne: *Arabian Medicine* (Cambridge University Press, 1962), p. 91.
[4193] J. Cox Russell: Late Ancient and Medieval Population, *Transactions of the American Philosophical Society*, vol. 48/III, 1958. A.N Poliak: The Demographic Evolution of the Middle East: population trends since 1348, Palestine and the Middle east, vol X. no 5, 1938; in Y. Courbage, P. Fargues: *Chretiens;* op cit; p. 35.

a. Islam's 'Intrinsic Hostility to Science:'

'Islam is a thousand leagues removed from reason and science.' (Renan)[4194]

By the time of Renan, that is the late 19th century, Islam's enmity to science, modernity, and civilisation was already, and for centuries, well established in most Western views and literature. Islamic teaching was deemed to produce despotism, fanaticism, ignorance, and hostility and hatred towards the rest of mankind.[4195]
Writing in the late 17th century, Charles Blount asserted confidently that Islam and Muslims are hostile to learning.[4196] At about the same time, Alexander Ross, presents Muslim religious orders as: 'wicked and irreligious,' observing various irreligious practices.[4197]
In *Doutes sur les Religions* (Doubts About Religions), translated from an English text in 1739, Toland claims that Prophet Mohammed ordered Muslims to be ignorant and have contempt for knowledge:

> 'Because he clearly saw that the spirit of inquiry would not favour him. This is how Islam maintained itself.'[4198]

Volnay, in the same century, in his *Voyage,* states:

> 'Far from solving the abuses of the state, Islam, is their very source..... Anyone who reads the Koran will be forced to admit that it has nothing on man's duties in society, or on political formation, or on principles of the art of governance; in brief, it says nothing about legislation.... It speaks with the voice of an obstinate, impassioned fanaticism.... [Muhammad] wanted, not to enlighten but to rule.'[4199]

Diderot, equally, in *letter of 30 October 1759*, held that the Prophet was the greatest enemy of reason; that he could not read or write, and so this encouraged Muslims to be hostile to, and have contempt for knowledge, which in turn secured the survival of Islam.[4200] The success of Islam, according to Diderot, is due to the fact that it left people with only two

[4194] E. Renan: L'Islamisme et la Science; Conference at the Sorbonne given on 29 March 1883; in *Oeuvres Completes* (Calmann Levy; Paris; 1947 edition), vol 1; p.947.
[4195] D.A. Pailin: *Attitudes*; op cit; p. 98.
[4196] C. Blount, Mr Gildon, and others: *The Oracles of Reason* (London; 1693), p. 84 ff.
[4197] A. Ross: Pansebeia; p. 120 fwd; in D.A. Pailin: *Attitudes*: op cit; p. 98.
[4198] in A. Gunny: *Images;* op cit; p.95.
[4199] C. Chasseboeuf (Volnay): *Voyage* in H. Djait: *l'Europe et l'Islam* (Le Seuil; Paris; 1974), p. 31.
[4200] D. Diderot: *Oeuvres Completes*; Vol VIII (Paris; 1975), at p. 230.

choices: beautiful women or extermination. Thus, the Prophet caused enlightenment to disappear 'in the din of battle and in the midst of pleasure.' And with the exception of the Qur'an, 'all books were burned, either because they were superfluous if they contained only what was in it (the Qur'an) or they were pernicious if they contained anything that was omitted from it.'[4201] Here, of course, like many of his peers, Diderot is referring to the infamous incident of the burning of the library of Alexandria, an incident always rekindled to justify Islamic antagonism to learning.

This was not particularly the view of Ocklay and Boulainvillers, supposedly more supportive of Islam, and who explain that the burning of the Library of Alexandria by the Muslims is more of a proof of 'devotion to the Qur'an than hostility to reason and learning.'[4202]

In truth, this library was never burnt by the Muslims. This accusation was made by the Christian historian, Bar Hebraeus (Abu al-Farraj), five centuries after the supposed event, and has been perpetuated since even if Gibbon had brought categorical proof that the said library was burnt centuries before Islam reached Egypt, and that its burning was in fact the deed of both Caesar and later Christian zealots.[4203]

Back to Diderot, who asserts that Muslim hostility to learning was evident in the time of Caliph al-Mamun, when people were heard shouting for his death because he (the Caliph) had fostered science at the expense of the 'holy ignorance' of the faithful believers; and this, as Gunny remarks, Diderot wrote in a serious Encyclopaedia.[4204]

In his sermons delivered at the university of Oxford, Joseph White, who was appointed to the Laudian Chair of Arabic in 1775,[4205] explained that wherever Islam established itself, people have lost their independence and freedom, their progress in science, invention and the love of learning have been stunted, and they have become indolent.[4206] White holds that the most important cause of Islam's success was 'the lack of culture of most Arabs, those of Makkah being particularly ignorant and illiterate. Joseph White, however, contradicts himself when he also says that they wrote beautiful poetry, before concluding that:

[4201] A. Gunny: *Images*; op cit; 168.
[4202] S. Ockley: *The History of the Saracens;* third edition (Cambridge; 1757) vol I; p.315; Henri, Comte de Boulainvillers: *La Vie de Mahomet* (1730), p. 46 ff.
[4203] E. Gibbon: *History of The Decline*; op cit; pp 452-4.
[4204] A. Gunny: *Images*; op cit; 168.
[4205] J. White: *Sermons Preached Before the University of Oxford,* in the year 1784 at the Lecture founded by the Rev. J. Bampton; 2nd edition (London, 1785).
[4206] In. D.A. Pailin: *Attitudes*; op cit; p. 98.

> 'A felicity consisting only of pure and spiritual pleasure would have been too refined for the uncivilised tribes.'[4207]

Admiral Bauffremont in his journal in the countries of 'Barbary' (North Africa) and the Levant, in 1766, says:

> 'All the people who recognise the Koran give rise to more or less the same reflection; it is everywhere the most odious and despicable of governments.'[4208]

Which is the same view largely carried into the 19th century by Chateaubriand, who sees in Islam the antithesis to civilisation, Islam proposing nothing other than war or a voluptuous life.[4209] And because of its fatalistic essence, Islam promotes despotism, with Muslims encouraged not to fight such despotism, and the only status left to the Arabs is to live as slaves.[4210]

Writing in the last quarter of the 19th century, the Frenchman Renan says:

> 'What distinguishes the Muslim, indeed, is essentially his hate for science; the conviction that research is useless, frivolous, and against the faith; the science of nature because it competes against God; history because it deals with pre-Islamic times, which thus carries ancient errors.'[4211]

Sir William Muir (1818-1905) Lt Governor of the vast territory known as the North West provinces of India), for his part, holds:

> 'We fail to find anywhere the germ of popular government or approach to free and liberal institutions.' Islam kept Muslim nations 'in a backward and in some respects barbarian state.'[4212]

This seemingly undeniable Islamic hostility to science and learning is contrasted with the superior Christian attitude, which fosters learning and progress. Joseph White, in his sermons at the University of Oxford, held:

> 'In belief, Islam is as naturally hurtful as Christianity is as naturally beneficial… to the intellectual, the social, and the religious character of man.'[4213]

[4207] A. Gunny: *Images,* op cit; pp. 181-2.
[4208] *Journal de campagne de l'Amiral de Baufremont dans les pays Barbaresques* (1766) ed. (M. Chirac; Paris; 1981), p. 43.
[4209] Chateaubriand: *Itineraire*; op cit; p. 908.
[4210] Ibid; p. 941-2.
[4211] E. Renan: *l'Islamisme;* op cit; p. 957.
[4212] W. Muir: *The Caliphate, its Rise, Decline and Fall* (Smith and Elder and Co; London; 1883), p. 599.
[4213] J. White: Christianity and Mohammedanism; sermon IX; p. 449; in D.A. Pailin: *Attitudes*; op cit; p. 98.

E.A. Freeman, Regius Professor of History at Oxford, judged 'the West to be progressive, legal, monogamous and Christian,' the East 'stationary, arbitrary, polygamous and Mahometan.'[4214] Palmer also agreed that Islam was a 'religion cognate, if inferior to our own'.[4215] In his caliphate, Sir William Muir concluded:

> 'The Islam of today is substantially the Islam we have seen throughout history. Swathed in the hands of the Coran, the Moslem faith, unlike the Christian, is powerless to adapt to varying time and place, keep pace the march of humanity, direct and purify the social life and elevate mankind.'[4216]

French Catholics, for their part were convinced that Islam did not just have satanic foundations,[4217] but Muslims religious orders were particularly dangerous as they were inspired by a virulent hatred of civilisation.[4218] The success of Europe over Islam in the 19th century, through Western colonisation, was thus deemed a sign of Christian superiority over fanatical, backward Islam; Christianity inherently favourable to progress, whilst Islam, by its nature, encouraging stagnation.[4219]

Whilst for religious Western Christians Islam was too decadent to aspire to learning, for the Western seculars, Islam was the anti thesis to learning, but for the very opposite reasons given by the Western clerics and religious scholars.[4220] The communists, Karl Marx and Engels were in agreement that Islam was a hindrance to progress, and in its removal from society was the road to progress. Engels saw the French invasion of Algeria as a positive act that was to lead to the civilisation of the country.[4221] Karl Marx, for his part, held that:

> 'Whatever may have been the crimes of England in India, she was the unconscious tool of history in bringing about... a fundamental revolution in the social state of Asia.'[4222]

[4214] E.A. Freeman: *The History and conquests of the Saracens* (Oxford: John Henry and James Parker; 1856; London; Mc Millan 1876), 3rd ed. pp; i.4.
[4215] In C. Bennett: *Victorian Images of Islam* (Grey Seal; London; 1992), p.99.
[4216] W. Muir: *The Caliphate;* op cit; p. 598.
[4217] M. Rodinson: *Europe;* op cit; p. 66.
[4218] Especially significant is the book by Abbot Rouquette of the Societe des missions Africaines of Lyons: *les societes secretes chez les Musulmans* (Paris; 1899).
[4219] M. Rodinson: *Europe*; op cit; p.66;
[4220] N. Daniel: *Islam, Europe;* op cit; p. 333.
[4221] Quoted by W. Bouzar: *Le Mouvement et la Pause* (Algiers; 1983), vol 1; pp 216-7.
[4222] K. Marx: Articles dated Sept 1859 and June 1853, in *On Colonialism.*

It is not just that Islam, it is claimed, stands against progress and learning, it also degrades and even destroys societies where it takes hold. Thus, for the missionary J.D. Bate (1836-1923):

> 'Islam reduces to a state of degradation every civilised state over which it obtains ascendancy and renders impossible the social and moral elevation, beyond a certain point, of even the most degraded people. Wherever Islam has obtained the sole ascendancy, the vast induction of twelve centuries tells one uniform tale-that the ascendancy has been the death knell of all progress and the signal for general stagnation.'[4223]

For Renan:

> 'Muslims are the first victims of Islam. Many times during my travels to the Orient, I have been able to observe that fanaticism is the work of a minority of dangerous men who keep the others in the practice of religion by the use of terror. To emancipate the Muslim from his religion would be the greatest service that would one would render him. By wishing these populations, amongst whom there are so many good people, deliverance from the yoke which bears on them, I do not think I express an evil wish.'

And, he concludes:

> 'Islam has weakened Muslim societies for five or six hundred years, killing science in these countries. Thus, the regeneration of Muslim society will not happen whilst Islam stands; revival will, instead, take place through the destruction of Islam.'[4224]

Today, more or less the same views hold. Again, the dominating Western perception, as Lueg notes, is that of a West that is progressive, rational, enlightened and secular, and an Islam that is backward, fanatical, irrational and fundamentalist.[4225] Amongst such modern apologists of Islamic enmity to science and modernity is Kung, who says:

> 'The result of this encounter (of Christianity) with the Reformation and secularisation has suggestive implications for Islam. Though we can readily understand disillusionment with scientific and technological advances, many observers of the whole development in Islamic countries are wondering: With greater exposure, voluntary or not, to the modern world, won't Islam ultimately have to go through these paradigm changes? The spread of Islam in the early Middle Ages, when it became a great

[4223] J.D. Bate: *The Claims of Ishmael* (London; W. Allen; 1884), p. 301.
[4224] E. Renan: *l'Islamisme;* op cit; p. 963.
[4225] A. Lueg: The Perception of Islam in Western Debate; op cit; p. 21.

cultural as well as political power, is unquestionably impressive (consider the adoption of Persian administrative methods, Hellenistic philosophy, and Indian medicine). Yet in modern times, to the regret of Muslims in all countries, Islam has increasingly slipped into a defensive posture with regard to scientific, technological, economic, and political developments in the West.'[4226]

Likewise, Bernal insists:

'The ultimate failure to associate science with the enduring features of Muslim religion was probably a major reason for its withering away in the later centuries of Islam, which became culturally and intellectually static.'[4227]

In the view of Hitti, a Christian Arab, an otherwise fervent admirer of 'Arab Civilisation':[4228]

'Modernisation on the intellectual spiritual level involves secularisation. Secularisation means more than separation between church and state. It replaces providential interpretation of historic events and current happenings to the individual with rational interpretation based on physical and psychological forces. Hardly a current issue of an Arabic newspaper lacks repeated mention of the name of Allah in connection with reports of birth and death, sickness and health, fortune and calamity success or failure, a relic of bygone thinking.'[4229]

Jean Claude Barreau says:

'The Islamic militants do not understand what is going on. They do not realise that they have been beaten by a modernity whose rationality is superior to the Muslim one. They (the Muslims) can buy modern weapons and even deploy them, but the victories of the West are not dependent on the quality of weapons alone, but rather on the system of its organisation.'[4230]

Muslim ineptness and backwardness, it is held, resides in the very tenets of Islam, such as the Sharia, or Ramadan (fasting), which as Daniel notes:

'Of Muslims it is said that they cannot become administratively efficient, let alone industrially productive, while they observe Ramadan.... The argument about Ramadan runs like this: If

[4226] H. Kung: *Christianity*; op cit; p. 53.
[4227] J.D. Bernal: *Science in History;* in Four volumes; Ca. (Watts and Co Ltd; London; 1969), Vol 1; p.275.
[4228] P.K. Hitti: *History of the Arabs* (Macmillan, London, 1970 ed).
[4229] P.K. Hitti: *Islam and the West: An Historical, Cultural Survey* (Princeton, 1962), p. 93.
[4230] J.C. Barreau: De l'Islam en General, et du monde moderne en particulier (Paris; Belfont le Pres aux Clercs; 1991), in A. Lueg: The Perception; op cit; p. 21.

Muslims keep Ramadan, they cannot compete, because it means a month when no work is done; and if they do not fast, they are no longer Muslims.... Ramadan has often been made an excuse for idleness.'[4231]

Daniel continues:

'I have heard bitter criticism of the strict observance of Ramadan, as if it were the survival of some evil practice with sinister fascist implications for the present.'[4232]

Islam's stern opposition to religious innovation is widened by Lewis to include innovations in other fields, such an opposition, according to him, the central cause of Islamic backwardness. He says:

'In the Muslim tradition innovation is generally assumed to be bad unless it can be shown to be good. The word *bid'a*, (innovation or novelty,) denotes a departure from the sacred precept and practice communicated to mankind by the Prophet, his disciples, and early Muslims. Tradition is good and enshrines God's message to mankind. Departure from tradition is therefore bad, and in time the word *bid'a*, among Muslims, came to have approximately the same connotation as heresy in Christendom.'[4233]

It is also argued that Islam forces Muslims into scholastic dogmatism, fanaticism, and a blind reliance on faith alone, marked by a debilitating fatalism, and contempt for visual arts,[4234] a view shared amongst politicians, public figures, intellectuals, and the media, such as the Italian Prime Minister, Berlusconi, who, in September 2001, equated Islam with darkness.

Anyone only assailed by the sort of literature just outlined will form the picture that Islam is, indeed, the most powerful agent of backwardness. Yet, reality is all too different.

First, the Sacred Text:

Islam, Anawati argues, 'of itself, did not offer any kind of opposition to scientific research; in fact quite the contrary;' the stimulus for science

[4231] N. Daniel: *The Cultural*; op cit; p. 80.
[4232] Ibid; p. 188.
[4233] B. Lewis: *The Muslim Discovery of Europe* (Norton; 1982), pp. 223-4.
[4234] M. Rodinson: *Europe;* op cit; p 127.

provided by the Qur'an, since God was glorified by wonder at His creation.[4235] Indeed, so goes the first verse of the Qur'an:

> "Read: In the name of your Lord Who creates, creates man from a clot. Read: And your Lord is the Most Bounteous, Who teaches by the use of the pen, teaches man that which he knew not." (Qur'an 96:105).

Throughout, the Qur'an repeatedly calls upon the believers to seek knowledge, observe and reflect:

> 'Say [unto them, O Muhammad]: Are those who know equal to those who know not? But only men of understanding will pay heed' (39: 9)
>
> 'In time, we shall show them our signs [ayatina] in the utmost horizons [of the universe] and within their inner selves.' (41:53)
>
> 'And He has subjected to you, as from Him, all that is in the heavens and on earth: behold, in that are signs indeed for those who reflect.' (45: 13)
>
> 'And he taught Adam the names of all things.' (2: 31.)
>
> 'Those truly fear God, among his servants, who have knowledge.' (35: 28.)

The Qur'an repeatedly uses the expressions:

> 'Why do they not reflect? Why do they not ponder?'

The Qur'an constantly encourages the use of intellect and invites people to think, investigate and analyse. So, notes Heinen:

> 'Muslims of all times have interpreted the Quranic counsels of considering the wonders of creation as the most effective promotion of scientific research.'[4236]

And as Garaudy observes:

> 'The importance granted to the sensitive perception of beings, who are visible symbols of the invisible God, allows the focus to be put on the experimental method, as against the lowly deductive speculations of the Greeks, of whom we saw none, in Athens, who was interested in the sciences of nature, practised in Asia Minor, and in Alexandria.'[4237]

The Qur'an also uses repetition in order to imbed certain key concepts in the consciousness of its readers and listeners.[4238] Allah (God) and *Rabb* (the Sustainer) are repeated 2,800 and 950 times respectively in the

[4235] G. Anawati: Science; op cit; p.778.
[4236] A. M. Heinen: Religion and Science in Islam, op cit; p. 863.
[4237] R. Garaudy: *Comment l'Homme*; op cit p.208.
[4238] Wan Mohd Nor Wan Daud: *The Concept of Knowledge;* op cit; p.32.

Qur'an; *Ilm* (learning/knowledge) comes third with 750 mentions.[4239] In the Islamic sense, learning is a form of worship by which humans are brought into closer contact with God. The more we learn about His creation, the closer we will be brought to Him.[4240] I and L Al-Faruqi make the point:

> 'God created the world and implanted in it His immutable patterns that make it a cosmos. He designed it in a way calling for wonder: perfect, orderly, malleable, its parts causally and theologically bound to one another... He invited man to study and investigate nature, to make the necessary deduction, and thus recognise, worship, and serve Him'. The Qur'an calls upon 'this widest possible scholarship, confident that men will find Islam's claims for God and His providence, for nature, for man and history, confirmed. It made a point of faith to discern the patterns of God in nature, an act of piety to articulate those patterns correctly and adequately; and an act of charity to teach them to others.'[4241]

This is a point reiterated by Igram:

> 'Islam negated the concept that God is a reserved Being sitting on His unreachable throne, His being actively and intimately connected with all the proceedings of this world. Thus, the Muslims felt that as God holds the keys to knowledge, man's purpose was to open the doors of ignorance by spreading this knowledge. This led them to view the entire universe as a divine gift for them to study in developing moral and intellectual strength to the utmost. In searching for knowledge, Islam strongly demanded that man study the sciences, since science itself is thought of as a divinely established system. To them, if God is the creator of the elements on which chemistry must rely, He is also the constructor of the solar system which the astronomer beholds, as He is the builder of the human biological system whose mind intrigues the philosopher, and to whose physiology the physician responds.'[4242]

And not just knowledge for the sake of knowledge as Scott notes, the Qur'an enjoins people to till the soil as an indispensable religious duty,

[4239] Ibid.
[4240] S.M Hossain: A Plea for a modern Islamic University; in *Aims and Objectives of Islamic education*; Ed by S.M. al-Attas; Hodder and Stoughton; King Abdulaziz University (Jeddah; 1977), pp 91-103.
[4241] I.R. and L.L. Al-Faruqi: *The Cultural Atlas;* op cit; p 321.
[4242] C. Igram: Roots of the Natural Sciences, Laurence Press Company, Cedar Rapids, 1981, p.7. quoted by M.H. Sadar: Science and Islam, is there a conflict; in *The Touch of Midas*; Z. Sardar ed (Manchester University Press 1984), p.17

and recommends the practice of farming, commerce, and the foundation and development of every sort of manufacturing industry.[4243]

The Qur'an, moreover, as Abdel Haleem sums up, was the starting point for all Islamic sciences.[4244] Arabic grammar was developed to serve the Qur'an; the study of Arabic phonetics was pursued in order to determine the exact pronunciation of the Qur'anic words; the science of Arabic rhetoric was developed in order to describe the features of the inimitable style of the Qur'an.[4245] As a consequence of the Qur'an, the Arabic language moved far beyond the Arab Peninsula, deeply penetrating many other languages such as Persian, Turkish, Urdu, Indonesian and others.[4246] The art of calligraphy was also cultivated through writing down the Qur'an, and the Qur'an is the basis of Islamic law and theology.[4247] And most Islamic sciences and aspects of civilisation, as seen in preceding chapters, also derive from the Qur'an. As the celebrated 15th century scholar Al-Suyuti, indeed, holds: 'Everything is based on the Qur'an.'[4248]

The association of the Qur'an with science has taken an even more radical path in recent times, as greater scientific discoveries and better translations of the Qur'an have allowed those learned in particular sciences to find lines in the religious text that anticipated these recent discoveries by over thirteen-fourteen centuries.[4249] Thus, the Frenchman Bucaille, noting the vastness of the scientific matter in the Qur'an, concludes that a high and diversified knowledge of science of an 'encyclopaedic' range was needed.[4250] His own experience in this respect is outlined here:

> 'These scientific considerations, which are very specific to the Qur'an greatly surprised me at first. Up until then, I had not thought it possible for one to find so many statements in a text compiled more than thirteen centuries ago referring to extremely

[4243] S.P. Scott: *History of the Moorish Empire*; op cit; Vol 1; p.109.
[4244] *The Qur'an: A New Translation* by M.A.S. Abdel Haleem (Oxford University Press, 2004-5), p. ix.
[4245] Ibid.
[4246] Ibid.
[4247] Ibid.
[4248] Ibid.
[4249] Seeking to show the scientific aspects of the Quran poses some great difficulties. The language of the Qur'an is very complex in places posing problems even for the best faquih (learned man) of Islam who disposes of an excellent mastery of Arabic. Hence, for those with little grasp of the language, or with little knowledge of the faith, to cogitate in one way or another about such a text is a misplaced effort.
[4250] M. Bucaille: *The Bible, The Quran;* op cit; p. 129.

> diverse subjects and all of them totally in keeping with modern scientific knowledge. In the beginning, I had no faith whatsoever in Islam. I began this examination of the texts with a completely open mind and a total objectivity. If there was any influence acting upon me, it was gained from what I had been taught in my youth; people did not speak of Muslims, but of 'Mohammedans', to make it clear that what was meant was a religion founded by man and which could not therefore have any kind of value in terms of God...
>
> My first goal was to read the Qur'an and to make a sentence by sentence analysis of it with the help of various commentaries essential to a critical study. My approach was to pay special attention to the highly accurate nature of certain details referring to them in the Book, which was only apparent in the original, struck me by the fact that they were in keeping with present day ideas, although a man living at the time of Muhammad could not have suspected this at all....
>
> What initially strikes the reader confronted for the first time with a text of this kind is the sheer abundance of subjects discussed: the creation, astronomy, the explanation of certain matters concerning the earth, human reproduction etc....[4251]

Islamic Tradition (The Hadith):

Far from calling for ignorance, as anti Islamic polemists claim, the Prophet insists in scores of Hadiths (Tradition) upon the acquisition of knowledge, as in the following:

> "Seek knowledge as far as China"
>
> "Seek knowledge from the cradle to the grave."
>
> "Seeking Knowledge is a duty upon every Muslim male and female.'

Again, leading by example, the Prophet made the first institution of Islam, the first mosque he built, into an institution of learning.

According to al-Ghazali:

> 'The Prophet regarded any day as lost in which he did not increase in that knowledge that would draw him closer to his Lord.'[4252]

[4251] Ibid. pp 128 ff.
[4252] Al-Ghazali: *Fatihat al-ulum* (Cairo 1904), p. 3; G.E. Von Grunebaum: *Islam* (Greenwood Press, Publishers, 1961), p.111.

The Prophet of Islam, in the words of Scott, said:

> "Teach science; whoever teaches it fears God; whoever desires it adores God; whoever speaks of it praises God; whoever diffuses it distributes alms; whoever possesses it becomes an object of veneration and respect. Science preserves us from error and from sin; it illuminates the road to Paradise; it is our protector in travel, our confidant in the Desert, our companion in solitude. It guides us through the pleasures and the sorrows of life; it serves us alike as an ornament among our friends and as a buckler against our enemies; it is through its instrumentality that the Almighty raises up those whom he has appointed to determine the good and the true. The memories of such men are the only ones, which shall survive, for their noble deeds will serve as models for the imitation of the great minds that shall come after them. Science is a potent remedy for the infirmities of ignorance, a brilliant beacon in the night of injustice. The study of letters is as meritorious as fasting; their communication is not inferior in efficacy to prayer; in a generous heart they awaken the most elevated sentiments; to the wicked they impart the corrective and humanizing precepts of virtue."[4253]

These words, spoken in the 7th century, Scott points out, were received by the Muslims with the respect due to a revelation destined to guide their policy, with reference to literary pursuits, through all subsequent ages.[4254] This is a point also echoed by Djebbar, who notes how the validation of the Prophet's message in its critical dimension, and the extreme care in the search of truth, contributed to create a scientific spirit. It also created a rational and intellectual corpus which has ultimately led to the flourishing of Islamic science.[4255]

Time and Place:

The critics of Islam ought to have noted the most obvious fact: If Islam was the cause of decline of Islamic science and civilisation, these would never have risen whilst Islamic religious power was at its highest (7th-13th) but would have done so only following the fall of the caliphate (1258). Yet, the rise of Islamic science and civilisation took place when the power of Islam was at its peak, 7th-13th century, and fell as soon as that power fell

[4253] S.P. Scott: *History;* op cit; vol 3; 518-9.
[4254] Ibid.
[4255] A. Djebbar: *Une Histoire*; op cit; pp.60-1.

(destruction of the Caliphate in 1258) (and loss of Spain in the 13th century.) This timing issue will be amply explored further on, but briefly here, any consultation of any reference work[4256] will show precisely how Islam accomplished its greatest achievements in science and civilisation from the 7th to the 13th, and declined from the 13th century onwards, precisely when its centres of power or civilisation (Cordova, Baghdad, Seville, Aleppo, Damascus…) were lost or destroyed.

Looking at this timing issue from another historical angle will also show, as Geanakoplos notes, that for centuries before the advent of Islam, the primitive Bedouin tribes of Arabia pursued uneventful lives, serving as minor allies to the Persians or Byzantines.[4257] Geanakoplos, then, asks:

> 'Why this people, originating in the Arabian peninsula- unorganised, disunited, and backward- would one day be able to overthrow the great Persian empire and wrest from Byzantium some of its choicest provinces is one of the great questions of medieval history.'[4258]

An answer given is by Campbell, who notes, that no sooner, Mohammed did preach 'that there is one God and that the figuring in sculpture of the human figure was not to be tolerated,' the warring tribes of Arabia Felix rapidly became welded into a single people under one religious and military commander.[4259] A point pursued by Durant:

> 'When Prophet Muhammed began preaching the word of Islam, Arabia was a desert flotsam of idolatrous tribes; when he died it was a nation.'[4260]

A similar point also made by Major:

> 'There are few events in history more interesting or more dramatic than the rise and spread of Islam,' [Major notes; in 622, Mohammed] 'was fighting for his life with a small band of devoted followers. A century later, the Arabs, fired with his zeal and his teachings, had conquered half the then known world. The greatest miracle that Mohammed performed was to weld bands of predatory warriors and brigands in Arabia into a compact nation, which swept away ancient kingdoms, and brought under one dominion an area nearly as large as that of the Roman Empire at the period of its greatest power.'[4261]

[4256] Such as *The Dictionary of Scientific Biography*, op cit; or G. Sarton's *Introduction*, op cit; etc.
[4257] D. J. Geanakoplos: *Medieval*; op cit; p.146.
[4258] Ibid.
[4259] D. Campbell: *Arabian Medicine*, op cit;: p.32.
[4260] W. Durant: *The Age of Faith*, op cit; p.174.
[4261] R. Major: *A History of Medicine*; 2 vols (Blackwell; Oxford; 1954), vol 1; p. 225.

It was a revolution from utter barbarism into the primary force of science and civilisation, too, no sooner than the new faith made its appearance.[4262] We look at the practice of medicine in pre Islamic Arabia, for instance, where disease was supposed to be an indication of the anger of God, which was the peculiar province of the sorcerer to remove.[4263] The primitive Arabs, Scott observes, conspicuous for their ignorance, were even more pronounced than was characteristic of other races not less barbarous.[4264] When, one compares this situation with the vast accomplishments following the rise of Islam as the chapter on medical sciences in the preceding part showed. (And this can be generalised to every single science or aspect of civilisation.) 'Using the word miracle,' as Sarton writes, is 'a symbol of our inability to explain achievements which were almost incredible. There is nothing like it in the whole history of the world, except for the Japanese assimilation of modern science and technology during the Meiji era....'[4265]

Any time, anywhere the new faith was carried, immense shifts in culture and civilisation soon took place. In central and Southeast Asia and in Africa, as I and L al-Faruqi observe:

> [Society moved from]: 'stone age Shamanism and animism directly into modernity upon conversion to Islam. The artefacts they left us from their first Islamic century (stone age tools, the highest available technology in the world at the time) testify to this tremendous jump of 'the human spirit under the aegis of Islam.'[4266]

In Europe, the prevailing conditions in its southern parts at the time of the Muslim arrival, according to Draper, consisted in:

> 'An observance of certain ceremonials constituted a religious life. A chip of the true cross, some iron filings from the chain of St.Peter, a tooth of a martyr, were held in adoration; the world

[4262] G. Le Bon: *La Civilisation*; op cit; G. Sarton: *Introduction*; vols 1and 2; op cit; R. Briffault: *The Making;* op cit; etc..
[4263] S.P. Scott: *History;* op cit; vol 3; p. 499.
[4264] Ibid.
[4265] Note 25 p. 27 in G. Sarton: *The Incubation*; op cit; p. 27, says: The earlier Japanese assimilation of Chinese culture was comparable in length to the Arabic assimilation of Greek culture, but it stopped there, while the Arabic achievements were only a link in the development of our own culture. For that reason we may neglect the Japanese culture, but we cannot overlook the Arabic one without a loss.
[4266] I.R and L.L. Al Faruqi: *The Cultural*; op cit; p.232.

> was full of the stupendous miracles which these relics had performed.'[4267]

The Muslim force which conquered southern Europe was nominally made up of Syrians, but was also composed of a mixture of peoples, Berbers, Arabs, Persians, many Jews, and considerable contingents of Arabized Byzantine Greeks.[4268] Whatever they were, Hyams insists, they were an improvement on the Wisigoths and Vandals; so much so that Andalusia has never been as productive of able men and valuable ideas as it was during the centuries of Islamic rule.[4269] By the end of the rule of Islam, this same southern Europe dragged Western Christendom into civilisation.[4270]

In Africa, Smith points out:

> 'We hear of whole tribes laying aside their devil worship, or immemorial fetish, and springing at a bound, as it were, from the very lowest to one of the highest forms of religious belief.'[4271]

And a shift not exerted by brutal force, the brute, in fact turning into a major force of civilisation once in contact with the new faith, the best example of this being the Mongols; once destroyers of civilisations, turning into the makers of a bright phase of India's history under their title of Mughals (16th-18th centuries). A point seized upon on a wider level by Smith:

> 'The practices that Mohammed forbade, and not forbade only, but abolished, human sacrifices and the murder of female infants, and blood feuds, and unlimited polygamy, and wanton cruelty to slaves, and drunkenness, and gambling, would have gone on unchecked in Arabia and the adjoining countries. The Mongols, the Tartars, and the Turks would have devastated, as they did devastate, the fairest regions of the earth without gaining that which, in some degree, softened their national character, and alone prevented their conquests from being unmitigated evil. In Northern and central Africa there would have been, not the semi civilisation of the Moors or of the Mandingoes, but the brutal barbarism of the fans and the Ashantees. The dark ages of Europe

[4267] J.W. Draper: *A History*: Vol I; op cit; p. 413-4.
[4268] E. Hyams: *A History of Gardens and Gardening*; op cit; p. 82.
[4269] Ibid.
[4270] See For instance:
C.H. Haskins: *The Twelfth Century Renaissance*; op cit;
R. Briffault: *The Making of Humanity;* op cit;
J. Vernet: *Ce que la Science;* op cit;
[4271] R.B. Smith: *Mohammed;* op cit; p. 38.

would have been doubly, nay trebly dark; for the Arabs who alone by their arts and sciences, by their agriculture, their philosophy, and their virtues, shone out amidst the universal gloom of ignorance and crime.'[4272]

The Role of Islam's first Institution, the Mosque:

The association of the mosque with education was one of its main characteristics throughout history, Tibawi observes.[4273] The school became, in fact, an 'indispensable appendage' to the mosque.[4274] From the beginning of Islam, Wardenburg explains, the mosque was the centre of the Islamic community, a place for prayer and meditation, of course, religious instruction, political discussion, but also a school. Anywhere Islam took hold, he notes, mosques were established, and basic instruction began. Once established, such mosques could develop into well-known places of learning, with hundreds, sometimes thousands of students, and frequently benefiting from important libraries.[4275] When a visitor entered a Muslim city he took it for granted that he could hear a scholarly lecture at the principal mosque at almost any hour of the day.[4276] For Pedersen, the starting point and centre of 'the prodigious literary activity' that developed in Islamic lands, was the mosque, in which every aspect of the intellectual life of Islam was cultivated.[4277] Once Mosque education was completed, for those who wanted to study further, the larger mosques, where education was more advanced, offered instruction in Arabic grammar and poetry, logic, algebra, biology, history, law, and theology.[4278] Once a student had been able to collect certificates from a number of teachers, he was in a position to seek employment in a mosque, college, law court, government office or village school.[4279]

The larger mosques soon evolved into the precursors of our modern universities in name, function and structure. *Djamiaa* (Arabic for university) evolved from the word *Djamaa* (mosque), expressing a parallel

[4272] Ibid; pp.125-6.
[4273] A.L. Tibawi: *Islamic Education* (Luzac and Company Ltd, London, 1972), p. 24.
[4274] S.P. Scott: *History,* op cit, vol 3; p.467.
[4275] J. Waardenburg: Some institutional aspects of Muslim higher learning, *NVMEN*, 12, pp.96-138; p. 98.
[4276] W. Durant: *The Age of Faith*; op cit; p. 236.
[4277] J. Pedersen: *The Arabic;* op cit; p. 20.
[4278] F.B. Artz: *The Mind;* op cit; pp. 150-1.
[4279] B. Dodge: *Muslim Education*; op cit; p. 25.

evolution in practice. Teaching and learning in most large mosques became, according to Mackensen, 'a fully fledged profession,' and the mosque school took on the semblance of an academy or even a university later on.[4280] These early mosques are the oldest universities still working today.[4281] Amongst these are al-Qayrawan and al-Zaytuna in Tunisia, Al-Azhar in Egypt, and al-Qarawiyyin in Fes, Morocco, all of them full fledged university institutions by the 9th-early 10th centuries.[4282] It is, indeed, precisely these early mosques that pioneered in much of the organisation we have today in our modern universities. This is obvious in the accommodation and welfare of large numbers of students. The Marrakech Kutubiya Mosque, for instance, accommodated at one time 25,000 students;[4283] whilst the mosque-universities of Spain, of Granada, Seville and Cordova attracted the learned communities of Asia, Africa and Europe. In the department of theology at Cordova, 4,000 students were enrolled, whilst the total number in attendance at the University reached almost 11,000.[4284] Dodge notes that generally students were assigned residential units, endowed to care for them, and also received free food. Every large unit also included a library, kitchen and lavatory, and some space for furniture.[4285] Better off students, however, generally resided in lodgings near the mosque. Students at the Qarawiyyin of Fes[4286] were fed daily and were also provided with accommodation.[4287] In Damascus, it seems, student welfare was much higher, the traveller, Ibn Jubayr pointing to the high number of facilities for foreign students and visitors at the Umayyad Mosque.[4288]

'Anyone in the West who seeks success,' [he says,] 'let him come to this city (Damascus) to study, because assistance here is abundant. The student here is relieved of all worry about food and lodging, which is a great help.'[4289]

[4280] R.S. Mackensen: Background of the History of Muslim libraries; op cit.
[4281] B. Dodge: *Muslim Education*; op cit; p 25.
[4282] R. Le Tourneau: *Fes avant le protectorat* (Societe Maroccaine de Librairie et d'Edition, Casablanca, 1947), pp. 453-471.
M. Talbi: Al-Qayrawan; in *Encyclopaedia of Islam,* Vol IV, pp 829-30.
J. Jomier: Al-Azhar; *Encyclopaedia of Islam*, Vol I, Leyden; Brill; pp. 813-21.
[4283] R. Landau: *Morocco* (Elek Books Ltd, London 1967), p.80.
[4284] S.P. Scott: *History*, op cit, vol 3; p. 467.
[4285] B. Dodge: *Muslim Education*, op cit, pp 26-7.
[4286] For details on Qarrawiyyin see R.Le Tourneau: *Fes*, op cit; pp. 453-71.
[4287] R. Landau: Morocco; op cit; p.106.
[4288] Ibn Jubayr in K. Totah: *The Contribution of the Arabs to Education* (New York; Columbia University Press, 1926), p. 45.
[4289] Ibid.

Advanced subjects of learning were taught in large measures in madrasas, hospitals, observatories, and the homes of scholars. In Spain, though, it was wholly the prerogative of the mosques, starting with the Cordova mosque in the 8th century,[4290] as was also the case for the principal mosques in other parts such as al-Azhar, for instance, where astronomy and engineering,[4291] and medicine were taught.[4292] At Al-Qayrawan and Zaytuna in Tunisia, alongside the Qur'an and jurisprudence grammar, mathematics, astronomy and medicine were taught.[4293] Al-Qayrawan was a centre of learning and Muslim enlightenment, resembling the University of Paris, which was to spring into existence some three centuries later.[4294] It had many scholars who specialised in medicine, especially under its Aghlabid dynasty (9th century), scholars such as Ishaq Ibn Amran at the court of Ziyadat Allah I and II, and Ishaq ibn Suleiman at the court of Ziyadat Allah III.[4295] These works were translated by Constantine the African (in 1065 ff) when he established himself near Salerno (Southern Italy), and they formed the foundation of Salernitan medical studies.[4296] The Qarawiyyin of Fes (9th century) was the principal centre of higher learning in Morocco.[4297] It included studies of the Qur'an and theology, but also law (Fiqh), rhetoric, prose and verse writing, logic, arithmetic, geography and astronomy.[4298] In Iraq, pharmacology, engineering, astronomy and other subjects were taught in the mosques of Baghdad, and students came from Syria, Persia and India to learn these sciences.[4299]

Mosques were fitted with large libraries, including considerable varieties of subjects, and even rare works. Pedersen refers to the large number of manuscripts that were found in the mosques of the Zaytuna in Tunis, Tlemcen in Algeria and Rabat in Morocco.[4300] The Zaytuna of Tunis, possibly, was the richest of all. It had several collections totalling tens of

[4290] J. Waardenburg: Some institutional, op cit, p. 101.
[4291] M. Alwaye: 'Al-Azhar...in thousand years.' Majallatu'l Azhar: (Al-Azhar Magazine, English Section 48 (July 1976): 1-6 in M. Sibai: *Mosque Libraries*, op cit, p 30.
[4292] J. Pedersen: Some aspects of the history of the madrasa' *Islamic Culture* 3 (October 1929) pp 525-37, p. 527.
[4293] H.Djait et al: *Histoire de la Tunisie* (le Moyen Age) (Societe Tunisienne de Difusion, Tunis), p. 378.
[4294] In H. Saladin: *Tunis et Kairouan* (Librairie Renouard; Paris; 1908), p. 118.
[4295] Ibid.
[4296] M. McVaugh: History of Medicine, in *Dictionary of Middle Ages;* op cit; Vol 8; pp 247-54.
[4297] B. Dodge: *Muslim Education*; op cit; p. 27:
[4298] R. Landau: *Morocco;* op cit; p.97.
[4299] Al-Khuli: *dawr al-masajid*, p. 20, in M. Sibai: *Mosque Libraries,* op cit p. 30.
[4300] J. Pedersen: *The Arabic Book*, op cit, p. 129.

thousands of books.[4301] Mosque libraries contained books on religion, jurisprudence and language, and also large numbers of scientific works and manuscripts. Abd al-Wahab located at the Qayrawan's Atiqa Library an Arabic translation of *Tarikh al Umam al-Qadima* (History of Ancient Nations) which was written by Saint Jerome sometime prior to his death in 420.[4302] Also, the same mosque library holds works such as Pliny's on botany which was translated from Latin.[4303] At the Qarawiyyin in Fes can be found the medical treatise by Al-Farabi dating from the 10th century, and also medical works by Ali Abbas al-Madjusi, Al-Zahrawi, *Urjuza* of Ibn Sina, etc.[4304] Similarly, in the book collection of the Qarawiyyin Mosque, Renaud is reported to have unearthed the original manuscript of *al-Urjuza al-Maluma*, the famous treatise on poisons and antidotes by the Andalusian scholar, Lisan al-Din Ibn al-Khatib (d 776H/1374).[4305] And at the Zaytuna, there were manuscripts on grammar, logic, documentations, etiquette of research, cosmology, arithmetic, geometry, minerals, vocational training etc.[4306]

Most of the illustrious scholars of Islam worked in such mosque/universities. At Al-Qarawiyyin, one of the most illustrious mathematicians of Islam: Ibn al-Banna (b. 1256),[4307] taught all branches of mathematics, which at this time included arithmetic, algebra, geometry and astronomy, and many students studied under him in a thriving academic community.[4308] At the same place, it is claimed, with little proof, that Gerbert first encountered Arabic numerals and the use of the zero; and there, more probably, Maimonides might have studied for a time; but certainly, the teaching staff included at diverse epochs many of the great medieval scholars such as Ibn Khaldun, Ibn al-Khatib, Al-Bitruji, and Ibn Harazam.[4309] Al-Azhar attracted Muslim scholars in large numbers, Ibn al-Haytham lived in its quarters for a long period, Al-Baghdadi taught medicine at the end of the 12th century, whilst Ibn Khaldun taught there

[4301] A. M. Abd al-Qadir. '*Al-Maktaba al-Tunusiya wa Inayatuha bi Almakhtut al-Arabi.*' Majallat Mahad al-Makhtutat al- Arabyia 17 (May 1971): 179-87, P. 186.
[4302] H. H. Abd al-Wahab, '*Bait al-Hikma al-Tunusi, Bath Tarikhi fi Awwal Musasa Ilmiya jamia fi al-Bilad al-Ifriqiya,*" Majallat Majma al-Lugha al-Arabiya (Cairo) 30 (1963-4), p 128, in M. Sibai, op cit, p 98.
[4303] A. Abd-Alwahab (1965-67) in H. Djait et al: *Histoire*, op cit, p. 193.
[4304] A. Tazi: La Mosquee, op cit, vol 1, p 124, and vol 2 p. 402.
[4305] in M. Sibai: *Mosque Libraries*, op cit, p. 99.
[4306] M. Abd al-Hafiz. *Fihris Makhtutat al-Maktaba al- Ahmadiya bi Tunis*. Beirut: Dar al-Fath, 1969. pp 8-9, in M. Sibai: *Mosque Libraries,* op cit, p. 98.
[4307] G. Sarton: Introduction; op cit; vol 2; p. 998.
[4308] J J O'Connor and E F Robertson: *Arabic Mathematics, a Forgotten Brilliance*; op cit;
[4309] R. Landau: *Morocco;* op cit; p.97.

towards the end of the 14th century.[4310] The Aqsa Mosque in Jerusalem, Islam's third holiest shrine, had four libraries, and next to it is the Mosque of Omar, which was founded during the reign of the second caliph Omar Ibn al-Khattab (Caliph 634-644). It developed rapidly into an important academy for religious and secular studies including large book collections in each of the mosque's four madrasas, one of these, the Nassiryia Madrasa, also known as the Ghazaliya in a tribute to the philosopher al-Ghazali (d. 1111) who sequestered himself there until he completed the writing of the celebrated work *Ihya al-Ulum Al-din* (The Revival of Religious Sciences).[4311] In the mosques, scholars of distinguished reputation recounted the results of their studies, their audience consisting of young, educated lay people, and also scholars.[4312]

b. Islam as 'a Fatalistic Faith, and Faith of the Occult':

It seems,' Crombie says, 'that in Islam there was no rational theology that could relate to rational science like that developed in Christianity by exegetical and philosophical evidence and argument,' which, he holds, accounts to a great extent for the failure of Arabic science after the 13th century.[4313] Garrison, for his part, insists on the fatalism of Islam:

> 'Even through the Crimean war, the Moslems and the Turks continued to pile their wounded in heaps and rows, and then desert them as being cheaper administration, albeit glossed over the somewhat pretentious fatalism of Islam.'[4314]

Just as does Campbell:

> 'The teaching of Islam, in accordance with the Qur'an, confirmed the belief in miraculous cures and 'medicine was tolerated'.[4315]

These assertions echo others seen above and in previous parts of this book, and countless others found in the vast Western writing on Islam. So, there is no need to repeat them here, and only refute them. First and

[4310] J. Jomier: Al-Azhar; op cit; pp 816-7.
[4311] M. Kurd Ali: *Khitat al-Sham*. 6 Vols (Damascus: Al-Matbaa al Haditha, 1925-8), 6: p. 119.
[4312] J. Pedersen: The Arabic; op cit; p. 20.
[4313] A.C. Crombie: Commitments and styles of European Scientific thinking: *History of science*, Vol 33 (1995) pp 225-238.p.234
[4314] F.H. Garrison: *Contributions;* op cit. p.22.
[4315] D. Campbell: *Arabian Medicine*, op cit: p.58.

foremost, as seen in the preceding section, the verses of the Qur'an call on people to reflect, understand, ponder etc. In which chapter of the Qur'an Campbell found Islam promoting miraculous cures must have been a unique copy he, unlike Muslims, was privileged to own. The foundation of Islamic experimentation, Draper explains, is the principle that it is possible to relieve the diseases of the human body by purely material means and as the science advanced it gradually shook off fetishisms.[4316] Draper, in fact, as noted earlier, contrasts Christian and Muslim attitudes, the former, when fever stricken or overtaken by accident, tried the nearest saint shrine and expected a miracle, whilst the Muslim relied on the prescription 'or lancet of his physician, or the bandage and knife of his surgeon.'[4317] Daniel also notes how Islamic theologians always fought popular beliefs in saints, relics and miracles, whilst in the West, there was exceptional attachment to the cults of relics, even secondary relics, 'as when the ground into which drained the water which had washed the bones of St Oswald had the power to expel devils from the bodies of the possessed.'[4318]

Prophet Mohammed also asserts:

> 'There is no ailment for which God has not created a cure.'[4319]

Prophet Mohammed, in a tradition familiar to all Muslims, is said to have linked in importance medicine with religion:

> ''Sciences is two fold: religion and medicine.''[4320]

Smith also explains how Islam 'is in the true sense of the word a spiritual religion,'[4321] rejecting the opinion of many critics that Islam is intrinsically fatalistic. Prayer, he suggests, would not play such central role in a fatalistic religion, since prayer presupposes that the human condition can be affected and Muslims respond to the muezzin's call 'prayer is better than sleep' with full confidence in the efficacy of prayer.'[4322]

Had Islam been fatalistic, as it is claimed, why then did Muslims, at the height of Islamic power, 7th-13th centuries, promote sciences, build dams and observatories, till the land, and so on and so forth. And if the Muslims were fatalists, as it is claimed, this fatalism has not led them to inaction, as

[4316] J.W. Draper: *A History*: Vol I; op cit; p. 411.
[4317] Ibid, vol II, p. 40.
[4318] N. Daniel: *The Arabs and Mediaeval Europe*; op cit. p.11
[4319] Sahih al-Bukhari (The most trusted piece of Hadith collection in Islam).
[4320] E.G. Browne: *Arabian Medicine* (Cambridge University Press, 1962), preface: viii:.
[4321] R.B. Smith: *Mohammed;* op cit; p. 264.
[4322] Ibid; p. 196.

Le Bon notes, because they founded 'a gigantic empire.'[4323] A point also made by Rosenthal:

> 'It would seem incredible that the 'dogma of predestination' should have permitted almost ten centuries of flourishing intellectual life to pass before it began to exercise its pernicious influence. Should we not rather assume that after the decay of intellectual activity mental inertia found in that 'dogma' an easy refuge?'[4324]

There is no place in Islam either for the occult, astrology or superstition. Al-Ghazali's passionate refutation of astrology has been seen.[4325] Ibn Hazm holds that the influence of the stars on people and events is an absurdity and defies the nature of things.[4326] Nor is there a place for alchemy. To Ibn Hazm, again, talisman, magic, music, and alchemy fall under the same category, for their pursuers are liars and shameless. To these abominable qualities may be added those of the alchemist, namely taking away people's money and falsifying it.[4327] On alchemy, Ibn Sina, in his *Epistle on the Elixir*, states:

> 'To assume that it is possible to turn silver the colour of gold, or copper the colour of silver, is tantamount to holding that there is a red dye which causes metals to become reddened and a white dye which causes metals to become bleached. Now we know that a mixture of colours of hard and stony bodies cannot be produced unless these bodies have first been softened and moulded. Moreover we obviously cannot soften and mould them unless they have been melted. Yet when they are melted it does not matter which red or white dye we use, since whenever colours are boiled over a fire they are destroyed and produce no effects; and whenever they fail to come to the boil they cannot be fixed by fire but evaporate, volatilise and escape, and are also of no use. Others neither boil nor subtilise and hence neither penetrate the metals nor mix with them and are again of no use. . .'[4328]

[4323] G Le Bon: *La Civilisation*; op cit; p.339.
[4324] F. Rosenthal: The Technique and Approach of Muslim Scholarship; *Analecta Orientalia;* 24; Roma; 1947. p. 4.
[4325] G. Sarton: *Introduction,* Vol II, p.93
[4326] Ibn Hazm: *Maratib al-Ulum, in Rasail Ibn Hazm;* ed I. Abbas; Cairo; 1952, p. 68; chap 9.in A. Chejne: *Muslim Spain*; op cit; p. 346.
[4327] Ibid.
[4328] See E.J. Holmyard and D.C. Mandeville's translation and edition of Avicennae *De Congelatione et Conglutinations Lapidum* (Paris; Geuthner; 1927), p.7; quotation found at: http://mercury.spaceports.com/~islam/Science%20Frame/alchemy.htm

It was also Islam, which, as soon as it came into contact with places rid them of witches, saints, miracles, gods, etc.[4329]

Islam restricts science, and makes faith supersede science in some specific areas. Science, for instance, is curtailed when it causes harm to other aspects of God's creation, as here clarified by Heinen:

> 'Scientific progress cannot be judged good and sane if it does not fit into the proven structures of a justice oriented society or a healthy environment. In Islam this social order and the harmony with a God created nature are directly derived from religion.'[4330]

Likewise, I and L. Al-Faruqi hold:

> 'For the Muslim, nature is a *ni'mah*, a blessed gift of God's bounty, granted to man to use and to enjoy, to transform in any way with the aim of achieving ethical value. Nature is not man's to possess or to destroy, or to use in any way detrimental to himself and to humanity, or to itself as God's creation. Since nature is God's work, his ayah or sign, and the instrument of His purpose which is the absolute good, nature enjoys in the Muslim's eye a tremendous dignity. The Muslim treats nature with respect and deep gratitude to its beneficial Creator and Bestower. Any transformation of it must have a purpose clearly beneficial to all before it can be declared legitimate.'[4331]

Muslim science, Garaudy notes, is intimately linked to a vision of the world, of man and God: that of Islam.[4332] Islamic science, as opposed to modern science, does not separate particular sciences from wisdom.[4333] It is significant that Al-Khazini, for instance, entitled his treatise on mechanics, hydrostatics and physics, *The Book of the Balance of Wisdom*.[4334] Al-Biruni, likewise, insisted that his experimental work was subject to the moral principles of Islam, for him, revelation was the supreme authority.[4335] Positivist Western science, on the other hand, Garaudy observes, has reduced sciences to being only techniques of manipulation of nature and man, and to develop a religion of means, offering, to satisfy the thirst of humans, a false infinity of desires and their de-measure.[4336] Islam, Sadar also observes:

[4329] R.B. Smith: *Mohammed;* op cit; pp.125-7.
[4330] A.M. Heinen: Religion and Science; op cit; p. 864.
[4331] I.R. and L.L Al-Faruqi: *The Cultural Atlas*; op cit; p. 322.
[4332] R. Garaudy: *Comment l'Homme devint Humain,* op cit; p.207.
[4333] Ibid; p.208.
[4334] Z. Sardar: *Exploration in Islamic Science*; op cit; p. 13.
[4335] Ibid.
[4336] R. Garaudy: *Comment L'Homme*; op cit; p.208.

> 'Does not differentiate between matters of 'state' and matters of religion. In this respect, Islam should not really be regarded as a religion for it is a total system. It is a religion, a culture, a civilisation-all at once. And as a holistic system it touches every aspect of human endeavour. Islamic ethics and values permeate all human activity.'[4337]

Moral ethics, thus, permeate all human activity. And so the scientists become accountable to God for their activities, required both to serve the community and protect and promote its ethical and moral institutions.[4338] Conflict can arise when science and its methods are made into an all embracing value at the expense of others.[4339]

Was the rupture with wisdom necessary to the development of science? The results obtained by Islamic science prove the opposite, concludes Garaudy.[4340]

Finally, it is worth stressing how Muslim scientists began their works with 'In the name of God the Merciful, the Compassionate'.[4341] And they went on expressing their self depreciating stand in front of God, with expression about themselves such as: 'the contemptible servant,' 'the repentant servant,' 'one who is in need of the mercy of his lord.'[4342] By this, they recognised that their science was of contemptible value in comparison with God's creation, the latter always superseding everything.

c. Islam 'Enmity to Scholars and Learning':

According to mainstream Western historians, as already partially noted above, Muslim scholars seem to have worked in a climate of religious persecution, and that their accomplishments were achieved outside the boundaries of the Islamic faith. As held by Wiet et al:

> 'Muslim scholars were showing a certain modification, increasingly at variance with the fanatic monotheism of the Kuran.'[4343]

[4337] M.H. Sadar: Science and Islam; op cit; p.17.
[4338] Ibid.
[4339] Ibid; pp.22-4.
[4340] R. Garaudy: *Comment l'Homme*; op cit; p. 208.
[4341] J. Pedersen: *The Arabic Book*; op cit; p.21.
[4342] L.A. Mayer: *Islamic Astrolabists; op cit;* P. 14.
[4343] G. Wiet et al: *History;* op cit; p.568.

And:

> 'No one wished to give the impression of forcing the pace, for fear of being charged with heresy. The misoneism of Islam is well known. To the mind of the Moslem community, all innovation was suspect and to be deplored as endangering unity or leading to the foundering of the law.'[4344]

Renan holds:

> 'Caliph Al-Mamun who introduced Greek learning was damned without pity by the theologians. Thus, to please the multitude exited and aroused by the Imams, books were burnt in city centres; books of philosophy and astronomy were thrown down wells; those who cultivated such sciences were called Zandiks, and were beaten in the streets; their houses burnt down, and whenever it suited them to increase their popularity, rulers put these scientists to death.'[4345]

And:

> 'In total, the intellectual growth represented by the Arab scholars was until the end of the 12th superior to that of the Christian world.' However, 'The day when fanaticism frightened the rulers, philosophy disappeared, manuscripts were destroyed by royal ordinance, and only the Christians recollect that Islamism had scholars and thinkers.'[4346]

Watt agrees:

> 'Throughout the centuries the ulema have used their authority to prevent the dissemination of all heretical or non Islamic views, and indeed of whatever deviated from their own teaching and from the Islamic self-image as they conceived it. The suppression or squeezing out of undesirable views has been carried out by methods not unlike those of western totalitarianism. In some Islamic countries at the present time it is virtually impossible for Muslim intellectuals to publish anything at variance with the dominant fundamentalism or traditionalism.'[4347]

And there are countless more instances of the sort.

Yet, again, historical evidence disproves this.

> 'It is revealing,' [notes Heinen,] that 'no responsibility for such an intrusion into scientific development has been assigned to the

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[4344] Ibid; p.547.
[4345] E. Renan: *l'Islamisme*; op cit; p. 955.
[4346] E. Renan: *Averroes et l'Averroisme*, 4th edition (Calman Levy, 1882), (foreword) p. iii.
[4347] W. M. Watt: *Muslim-Christian*; op cit:p.44.

> Islamic religious authorities, as has been the inquisition trials in Christian countries.'[4348]

This is, indeed, confirmed by concrete facts from historical experience. Muslim astronomers and geographers, for instance, were in agreement in stating the spherical shape of the earth, a notion which in Western Christendom, until modern times, led its authors to the stake. In the world of Islam, Dreyer explains, there was no record of any Muslim being persecuted for stating that the earth was a sphere that was capable of being inhabited all over; and that it was also very small compared to the size of the universe.[4349] Sarton, too, notes how in Eastern Islam, at least three astronomers: Ali ibn Umar al-Khatibi, Qutb al-Din al-Shirazi and Abu'l Faraj discussed the earth movement, a question that was hardly discussed in the West.[4350] In Sarton's own words:

> 'The fact that great scholars found it necessary to prove the fixity of the earth implies that they themselves and others had considered the alternative. Many people may have thought that the earth was moving, but they did not know that it was. To believe such a thing would have been in itself of little importance; the true scientific achievement was to change that belief into conviction, and that was to be the work of a later time. In the meanwhile the eastern discussion of the question was superior to the Western ignorance of it.'[4351]

Ibn al-Haytham's optics, as another instance, Draper observes, 'does not depend upon mere hypothesis or supposition, but is plainly based upon anatomical investigation as well as on geometrical discussion.' And Draper goes on to say:

> 'He determines that the retina is the seat of vision, and that impressions made by light upon it are conveyed along the optic nerve to the brain. Though it might not be convenient at the time when Ibn Al-Haytham lived, to make such an acknowledgement, no one could come to these conclusions, nor indeed, know anything about these facts, unless he had been engaged in the forbidden practice of dissection.'[4352]

We are also told of remarkable exchanges between al-Biruni and Ibn Sina on issues relating to metaphysics, the creation of our universe, and other matters, which 'showed the working of the two great minds of their age, their unity and contradictions, development of ideas in peripatetic and non

[4348] A. M. Heinen: Religion and Science in Islam; op cit. p. 862.
[4349] J.L.E. Dreyer: *A History of Astronomy; op cit* p. 249.
[4350] G Sarton: *Introduction*; op cit; Vol II,. p. 759.
[4351] Ibid.
[4352] J.W. Draper: *A History*; op cit; vol 2; p. 45

peripatetic schools of thought, and approach to problems; but also reflect upon the scientific spirit of research and inquiry diffusing during that period.'[4353]

All these instances, and countless more, besides the thriving scientific activity seen in part two, contradict the generally held assumption by Western historians that the Islamic scientific activity took place in a climate of fear and persecution.

Islam went as far as tolerating, promoting, adopting and developing the sciences of all other cultures, without any fear. At no point, in its vast land, did the early Muslims seek to destroy what they found symbolising the culture and civilisation of pre-Islamic peoples and nations (except the multitude of idols representing gods). The Pyramids survived. So did all the artefacts and remains of Greece and Rome, and pre-Islamic Mesopotamia. Scott, for instance, observes, how, unlike their predecessors the Barbarians and their own conquerors the Castilian, the Muslims of Spain, for instance, did not take pleasure in the destruction of 'the proud memorials of Roman greatness.' When a structure was hopelessly ruined, they appropriated the materials for their own edifices, but always forbade themselves wanton injury of the relics of classic antiquity.[4354] On the other hand what has remained of Aztec and Maya brilliance? What happened to the centuries old remains once Western colonial powers set foot in Egypt, Algeria, India…?

Upon Islam also hangs the accusation of burning books and libraries. Von Grunebaum uses this instance to show Islamic enmity to books:

> 'Similar is the story told by Tanuhi (d.994),[4355] in which, under the impact of a dream, a man tears up Galen's Anatomy as an irreligious book.'[4356]

Wiet et al, for their part, say:

> 'Bukhara, extremely rich and containing rare works which were consulted by Avicenna. 'I saw there,' he declared, 'works of which many people have never heard, works I had never seen

[4353] Barani: Al-Biruni, pp 60-2; The same author: *Avicena Commemorative Volume*: Ibn Sina and al-Biruni, Iran Society, Calcutta; as outlined in H.M. Said and A.Z. Khan: *Al-Biruni; His Times, Life and Works* (Hamdard Academy; Karachi; 1981), at pp. 105-6.
[4354] S.P. Scott: History; op cit; vol 1; p. 617.
[4355] Tanuhi: *Nishwar al-muhadara*, II, trans D.S. Margoliouth, *Islamic Culture*, V (1931), 171 (no 2).
[4356] G.E. Von Grunebaum: *Islam*, op cit; note xix . p.250.

> before, and have not seen since. It was destroyed in a fire.[4357] The library founded in 993 in Baghdad by the Vizier Sabur contained more than 10,000 volumes, many of them signed. Most of them spoilt by worms fifty years later; the library itself burned when Toghrul beg entered Baghdad.... the Mongols burned the valuable library of Savah in 1220. The same splendour, and the same eventual series of disasters are to be seen in Moslem Spain.'[4358]

These views echo countless others insisting on Islamic fanaticism and burning of books.

These views are fallacious, though. First, they carry their own criticism. Von Grunebaum uses one instance of one dream to turn it into a generalised fact, condemning Islamic civilisation. Wiet and his group, for their part, mingle the facts on purpose. They speak of book burning, but judiciously, or insidiously, they mingle facts and the authors of such burnings, and do not refer to those who burnt most Muslim books: the crusaders, the Church in Spain and Sicily, and colonial authorities later. By failing to clarify this point, Wiet et al deceive those not aware of who did what, and leave the impression that the Muslims themselves burnt their libraries.

Furthermore, as part one, in its section on books and libraries has shown, it was the Muslims who, first in history, manufactured books on a large scale, and it was they who set up the first public libraries, open to all. And, one cannot reconcile the view amongst Western historians, which claims on one hand that the Muslims are book burners, and yet on the other claims that they preserved/stole/plagiarised the learning of the Ancients. It is one or the other.

The burning of the Alexandria Library is one of the instances used to prove the Muslims as book burners.[4359] Voltaire even excuses 'the Arabs for burning the Alexandria Library'.[4360]

Yet, this story is reported five centuries after the said incident supposedly happened, which makes it highly doubtful. More importantly, this library had burnt centuries before the Muslims entered Egypt. Cahen, referring to Meyerhof, says that it was perhaps 'as an echo to the discussions of the end of the 12th century,' that we find surfacing at that epoch the legend by

[4357] G. Wiet et al: *History*; op cit; p.454-5.
[4358] Ibid.
[4359] P. Duhem: Medieval Physics, in R. Palter edition: *Toward Modern Science* (The Noonday Press; New York; 1961), Vol 1; pp 141-59; at p. 141. W. M. Watt: *Muslim-Christian*; op cit; p. 33.
[4360] Voltaire: Essai sur les Moeurs; Chapter VI; in P. Martino: *l'Orient dans la Literature Francaise au 17em et 18em siecles* (Librarie Hachette; Paris; 1906), p. 319.

which the Arabs, during their conquest of Alexandria, had destroyed the famous library of that city whilst it had been demonstrated that it existed no longer.[4361] Campbell, too notes, how legend has it that the papyri containing the Greek scripts were used as fuel for the 4,000 baths of Alexandria for the period of six months. This legend has nothing to recommend it.[4362] Equally, Benoit and Micheau recognise that the Muslims respected the existing situation, and that the burning of the Library of Alexandria by the Muslims is 'a myth that needs to be exposed as such.'[4363] Le Bon also makes the point:

> 'As for the burning of the Library of Alexandria, that act of vandalism was so contrary to the habits of the Arabs, that one wonders how could such a story be accepted by serious writers. It has been so clearly disproved in our era to warrant further attention. Nothing has been easier than proving, via clear citations, that, well before the Arabs, Christians had destroyed the pagan books of Alexandria with so much care, that there was nothing left to burn.'[4364]

Gibbon, too, devotes a whole lengthy section to this matter to disprove the fact that the Muslim burnt the said library. He blames instead Caesar and Christian zealots.[4365] It was, indeed, when Christianity became the official religion, that Emperor Theodose, and not Caliph Omar, who had 'the temples and the books of the pagans destroyed.'[4366]

It is Butler, however, who makes the best argument against the legend that the Muslims burnt the Alexandria Library. It is worth reproducing his argument in good detail:

> 'I have shown that:
> 1) The story makes its first appearance more than five hundred years after the events to which it relates.
> 2) On analysis the story resolves into absurdities;
> 3) The principal actor in the story, viz., John Philoponus was dead long before the Saracens entered Egypt.
> 4) Of the two great public libraries to which the story could refer, a) the Museum library perished in the conflagration caused by Julius Caesar, or if not, at a date not less than four hundreds year anterior to the Arab conquest, while b) the Serapium Library

[4361] M. Meyerhof: Von Alexandrian nach Baghdad, in Sitzb. Pr.Ak (1930); in C. Cahen: *Orient et Occident au temps des Croisades* (Aubier Montaigne, 1983), p.211.
[4362] D. Campbell: *Arabian Medicine*; op cit; p.32.
[4363] P. Benoit and F. Micheau: The Arab Intermediary; op cit; p. 197.
[4364] G. Le Bon: La *Civilisation des Arabes*, op cit; p.162.
[4365] E. Gibbon: *The Decline and Fall*; op cit; vol 5; pp 474-5.
[4366] G. Le Bon: *La Civilisation des Arabes*, op cit; p..163.

either was removed prior to the year 391. Or was then dispersed and destroyed; so that in any case it disappeared two and half centuries before the Muslim conquest;
5) The 5th and 6th and early 7th century literature contains no mention of the existence of any such library.
6) Nevertheless, it had existed when Cyrus set his hand to the treaty surrendering Alexandria, yet the books would almost certainly have been removed-under the clause permitting the removal of valuables-during the eleven months armistices which intervened between the signature of the convention and the actual entry of the Arabs into the city;
7) If the library had been removed, or if it had been destroyed, the almost contemporary historian and man of letters John of Nikiou, could not have passed over its disappearance in total silence.[4367]

Despite all this evidence, the legend of the Muslim burning of the Alexandria Library still thrives. Hence, in his article on the rise of Algebra and the Creation of Algebraic geometry, Segre insists on the destruction of the library by the Arabs in 611, in the process, and for good measure, moving forward by decades the Arab entry into Egypt (which in reality took place in 640).[4368]

In relation to burning scholars, it is not in Islam where they were burnt, but it is amongst the ancestors of our modern historians accusing Islam of the deed that we find the burning alive of countless numbers of beings, including considerable numbers of scholars.[4369]

In truth, rather than burning books, being a fatalistic faith, or that it repressed scholars, or that it was inherently hostile to science, Islam, in fact, acted as the main force that stimulated the rise of learning during the Islamic golden era: 7th-13th century, as is shown in the following.

[4367] A.J. Butler: *The Arab Conquest of Egypt* (Oxford; 1902); p. 424. This account is derived from a memorandum addressed by M. Awad, former leading official at UNESCO to the Journal of World History; in a Note on the Alleged Destruction of the Alexandria Library by the Arabs; in *Cahiers d'Histoire Mondiale*; vol 8; pp. 213-4.
[4368] B. Segre: The Rise of Algebra and the Creation of Algebraic Geometry; *Journal of World History;* VII; 91963); pp. 383-406; at p. 387, in A Note; op cit; p. 213. Heard by this author on the BBC World Service early in the 1990s.
[4369] See, for instance, J.W. Draper: *History of the Conflict*; op cit.
H.C. Lea: *A History of the Inquisition*; op cit, etc.

d. The Spur of Islam to Science and Learning:

Kramers says:

> 'The Arabs, certainly did not grasp the meaning of everything (in the Qur'an) intellectually, but it gave them the backing they needed to do great things and think great things. It made them believers in God's oneness and in the mission of Muhammad and it made them submissive to God's commands. It tore them away from an unimaginative and hard life and gave them the force to create a new world, materially and spiritually.'[4370]

It became a matter of popular belief, as firmly grounded as the most sacred tradition, Scott insists, that the diligent cultivation of the mental faculties was an imperative religious duty.[4371] I and L. Al-Faruqi, too, explain that Islam identifies with knowledge, and so makes knowledge both its condition and its goal, equating the pursuit of knowledge with *ibadah* (worship) and pouring lavish praise on those who committed themselves to knowledge.[4372] Sayili notes how the creation of institutions of learning, hospitals, universities, or public libraries, all took 'firm root' in Islam, 'where piety and learning were in many respects inseparable.'[4373] Islam is said to be responsible for the fantastic tales of bags of jewels and gold paid for a few pages of a rare pharmacological or astronomical manuscript.[4374] The rooting of intellectual life in religion, the basis of Muslim society, Pedersen observes, created a respect for it such that rulers and rich men 'opened their doors to the representatives of the intellectual life,' and frequently lavished large sums of money on them.[4375]

The urge to acquire and disseminate knowledge has never been as passionate as under early Islam. Thousands upon thousands were the seekers of knowledge criss-crossing the vast Muslim land mass of the Asian, African and European continents just in order to acquire and disseminate knowledge among Muslims and non Muslims alike.[4376] They travelled thousands of miles in search of a person who might provide an

[4370] J.H. Kramers: Sciences in Islamic Civilisation. *Analecta Orientalia: Posthumous Writings and Selected Minor Works of J.H. Kramers*; Vol 2 (Leiden; Brill; 1956), p.78.
[4371] S.P. Scott: *History* ; op cit; Vol 1; p.64.
[4372] I.R and L.L. Al-Faruqi: *The Cultural Atlas*; op cit; pp.230-2.
[4373] A. Sayili: *The Observatory in Islam*; op cit; p. 1.
[4374] I.R and L.L Al-Faruqi: *The Cultural*; op cit;p.232.
[4375] J. Pedersen: The Arabic Book; op cit; p 21.
[4376] M.H. Sadar: Islam; op cit; p.19:

insight into a mathematical problem.[4377] Mosques instantly were turned into classrooms, and so were the streets, marketplaces, and private homes.[4378] Scholars such as Al-Ghazali, al-Farabi, and Ibn Sina, amongst many more, after teaching in public schools, retired to their private libraries and studies, and continued teaching 'those fortunate enough to be invited.'[4379] A great liberality, which, according to Wilds, was one of the most potent factors in the brilliant and rapid growth of Muslim civilisation; education so universally diffused that it was said to be difficult to find a Muslim who could not read or write.[4380] Even the blind, according to Scott:

> 'Though hampered by the unkindness of nature, were still able, in that age of intellectual rivalry, to attain a high rank in the scale of literary excellence.'[4381]

The pupils, like the teachers, Artz notes, were held in high esteem, and the large libraries collected by the wealthy landed aristocrats and merchants showed that as during the Italian Renaissance six centuries later, knowledge 'was one of the marks of a gentleman.'[4382]

As it expanded, Islam widened this passionate union of learning and religious duty to vaster lands and larger diversities of peoples. The Islamic world, Scott explains, included an even greater diversity of climate and nations than that of Rome; 'the ties of universal brotherhood' proclaimed by the Qur'an; the connections demanded by the requirements of an extended commerce; the intimate associations encouraged by the pilgrimage to Makkah, awakened the curiosity and enlarged, in an equal degree, the minds of the Muslims of Asia, Africa and Europe.[4383] Inquiry into the surrounding world, Von Grunebaum also says, was dictated by the needs of the community: the technique of administration, the principles of taxation, and the organisation of the community as such came under scrutiny, with a comprehensive doctrine of political institutions developing as a result.[4384] Geography, for instance, flourished when the government required exact descriptions of the areas under its authority; and so did history. Because the latter yielded information

[4377] I.R and L.L Al-Faruqi: *The Cultural*; op cit;p.232.
[4378] Ibid; pp.230-2.
[4379] M. Nakosteen: *History*, 1964, P.48.
[4380] E.H. Wilds: *The Foundation of Modern Education* (Rinehart & Co., 1959), p. 216
[4381] S.P. Scott: *History*; op cit; Vol 3: p. 431.
[4382] F.B. Artz: *The Mind;* op cit; p.151.
[4383] S.P. Scott: *History;* op cit; Vol 1; p.324.
[4384] G.E. Von Grunebaum: *Islam* (Greenwood Press, Publishers, 1961), Chapter VI p.113.

concerning the life of the Prophet and the rise of Islam-it was needed for establishing precedent, legal and religious.[4385]

The daily practice of Islam also spurred scientific growth and, in its essence, Islam shaped and advanced Islamic civilisation. In sciences, arithmetic was encouraged and stimulated because it was needed to calculate inheritances and to count days and years, whilst geometry helped find the direction of Makkah and the pilgrimage routes, and from astronomy Muslims could determine the beginning of Ramadan and the great feasts, and fix the time for prayers.[4386] The Muslims also considerably improved techniques of astronomical observation and cartography because they needed accurate determination of positions for the correct orientation of the mosques.[4387] There is no doubt, Sayili insists, that the utility of astronomy as a 'handmaiden of religion' was accepted universally recognised in Islam, and as a result the consistent patronage of the *Muwaqqit* (time keeper,) the mosque was the scene of astronomical work of at least a limited scope.[4388] During the period of installation and consolidation of Muslim power in Spain and of the Maghrib, Djebbar explains, medicine and calculation were the first scientific disciplines to benefit from teaching, followed by the publication of works. This was in response to the needs of certain well-to-do ranks of society of the cities, or to the solicitations of lawyers for the solution of certain problems such as those involved in land measurement or in the partitioning of inheritance.[4389] Djebbar dwells on the Moroccan mathematician, Ibn al-Banna, whose *Tanbih al-albab* contains precise mathematical answers to the calculation of the drop of irrigation canals, the arithmetical explanation of a verse of the Qur'an concerning inheritance, the determination of the hour of the third daily prayer, the enumeration of delayed prayers which have to be said in a precise order, the exact calculation of legal tax in the case of a delayed payment, etc.[4390]

Trade and industry likewise thrived under the impetus of the faith. Muslims became bound to a strict code and practice of trade as commanded in the Qur'an (Qur'an 2: 282 ff), and this summon to record commercial deals, loans, led them to develop great skills in recording companies and associations, loans, accounts, and making contracts, thus

[4385] Ibid.
[4386] O.A. Farukh: *The Arab Genius;* op cit; p.35.
[4387] G.T.H. Kimble: *Geography in the Middle Ages* (Methuen and Co; London; 1938), p. 63.
[4388] A. Sayili: *The Observatory*; op cit; p. 26.
[4389] A Djebbar: *Mathematics;* op cit.
[4390] Al-Ballagh; Djebbar, 1995, b, in A Djebbar: *Mathematics*.

establishing the very foundations of modern trade. Many industries developed and thrived also as a direct consequence of the faith, and even due to the restrictions of the faith. The glass industry, as seen in the first part, thrived largely due to the fact that glass (just as faience) was required to replace the gold and silver vessels excluded on the grounds of faith.[4391]
One particular reason why lustre painting on glass and faience is owed to Islam is due, as Weiss explains, to the denunciation in the Qur'an of luxury, which compels Muslims to use other materials in place of gold and silver.[4392]
Islamic art, in its uniqueness and beauty, is also a direct outcome of the faith. Islamic art rejects any representation of God's creation, especially living creatures. Hence, Garaudy notes:

> 'To turn the visible what is invisible through the abstraction of geometry and the rhythm, this is the sort of aesthetics inspired by the Muslim conception of divine transcendence....
> Islamic painting will depart from this refusal to imitate sensitive appearances, which derive, according to it, from Qura'nic requirements. In fact, the Qur'an forbids idols, but not images. The Hadith however, goes further, condemning mainly images (which carry shadows), which means statues. More deeply, the image, if it seeks, through imitation of the individual, sensitive world, to compete the act of God, is sinful, because it associates the relative to the absolute....
> Muslim aesthetic is thus the application to the arts of the profession of the faith of Islam, of the transcendence and unity of God: 'There is no god but God'...
> This translates itself notably, in architecture and decoration, through abstraction; in painting, through the birth of an autonomous world, ruled by its proper laws, and escaping hence the pretence of godlessness, and creating a nature in God's manner.'[4393]

Burckardt also explains that visual Islamic art, for instance, is but the visual reflection of the Qura'nic world; it cannot be otherwise.... Islamic art does not reflect the stories and parables contained in the Qur'an as Christian art, for instance depicts the episodes of both testaments.[4394] Islamic art, Burckardt continues, is fundamentally derived from *tawhid*, that is:

[4391] G. Weiss: *The Book of Glass*; op cit; p. 65.
[4392] Ibid; p. 72.
[4393] R. Garaudy: *Comment l'Homme*; op cit;p.198-9.
[4394] T. Burckardt: Perenial Values in Islamic Art: in *The Islamic Review*, September 1967; pp 34-40; p. 40.

> 'From an assent to or contemplation of Divine Unity. The source of *al-tawhid* is beyond words; it reveals itself in the Qur'an by sudden and discontinuous flashes. Striking the plane of visual imagination, these flashes congeal into crystalline forms.'[4395]

Islam further stimulated exact sciences through its insistence upon evidence, which gave rise to both testing and experimenting. Thus, whilst the Greeks excelled at speculation to reach conclusions, Muslims obtained knowledge through *istidlal* (calling for evidence), seeking through evidence to make the unknown known, became fundamental. *Istidlal*, I and L Al-Faruqi note, implies 'observation of the data and their examination through experimentation, measurement and more observation...'[4396] This Islamic practice is largely derived from one fundamental Islamic trait: the extreme rigour adopted in the collection of the verses of the Qur'an and of the Prophet's sayings (the Hadiths.) In the latter case, Imam al-Bukhari, in selecting the Prophet's Hadiths, imposed upon himself in his selection the most extraordinary effort and energy, paying the most minute attention to detail, rejecting from his collection of tradition anything that failed to reach his strictest parameters of exactitude.[4397] In following such precepts, Ibn al-Nafis declared that dissection had proven both Galen and Ibn Sina wrong; whilst al-Biruni refused to accept any statement without testing it in experience and confirming it by examination.[4398] Muslims developed instruments to correct and expand the sensory evidence, and would repeat experiments as a means to test results and avoid error. Jabir ibn Hayyan had a special name for scientific experiment, *al- tadrib*; and ibn al-Haytham called it *al-itibar*.'[4399] Muslim science embraced the knowledge of the sky and stars (astronomy) as well as surgery and ophthalmology in such precise and meticulous attention for detail that it amazes us today.[4400] Which explains why Muslims carried out accurate observations and

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[4395] Ibid.
[4396] I. And L.L. Al Faruqi: *The Cultural;* op cit; p. 322.
[4397] J. Robson: Al-Bukhari: *Encyclopaedia of Islam*; New Series; Vol 1; pp. 1296-7. p. 1296:
[4398] See for instance the excellent and detailed account of Al-Biruni's experiment at Nandana; in N.A. Baloch: Biruni and his experiment at Nandana; in *ERDEM* 3 (1987); pp 673-729.
[4399] I.R And L.L Al Faruqi: *The Cultural*; op cit; p. 322.
[4400] See for instance:
-E.S. Kennedy: *Astronomy and Astrology in the Medieval Islamic World* (Aldershot; Variorum; 1988).
-H.R. Turner: *Science in Medieval Islam* (Austin; Texas; 1997).

devised extremely accurate instruments,[4401] why they also were the first to devise accurate sea charts, and their maps guided navigators in the then great unknowns and mysteries of the seas and oceans, and why they made measurements of weights and densities so accurate that modern day science agrees with them, and why they wrote pharmaceutical formulae, which are still current.[4402]

The major source in the shift of sciences from the generally speculative character of the Greeks to the practical aspects of the Muslims also owes much to the faith. Knowledge in Islam, indeed, is not an end in itself, but is a means for solving the problems of the community.[4403] The pursuit of pure knowledge for the perfection of humanity is encouraged, and science, far from being enjoyed as an end in itself, ought to be instrumental to the attainment of a higher goal.[4404] Islamic science, in the words of al-Faruqi, is neither 'an involuntary flash in the consciousness... nor is it some esoteric information obtained on authority after initiation, or an illumination arrived at subjectively through contemplation. Rather, Islamic knowledge is the rational-empirical and intuitive-apprehension of every realm of reality. It is the critical knowledge of man and history, of earth and heaven. It is the practical knowledge that produces results and leads to virtue, the object of the Muslim's prayer.' 'O God grant us a knowledge that is useful and beneficial.'[4405] The classical scholars of Islam were concerned that in the pursuit of knowledge the needs of the community should not be lost from sight, that knowledge should not tend to such a level of abstraction that it leads to the estrangement of man from his world and fellow humans.[4406] Consequently, when the Muslims at the beginning of their ascendancy directed their attention to intellectual activity, Farukh notes, they turned first of all to the practical sciences, that is, those which would yield them an immediate profit, either in private individual life or in the religious life of the community, such as mathematics, astronomy, and medicine.[4407] Behind the division of knowledge by Al-Ghazali, for instance, into individually and socially requisite and praiseworthy and blameworthy, is a deep commitment to

[4401] See: for instance: H. Edwards: *Patterns and Precision: the Arts and Sciences of Islam* (Washington; 1982).
[4402] See:
D.R. Hill: *Science*; op cit.
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[4403] M.H. Sadar: Science and Islam; op cit; pp.22-4.
[4404] Z. Sardar: *Explorations in Islamic Science* (Mansell; London; 1989), p. 85.
[4405] I.R. and L.L. Al-Faruqi: *The Cultural*; op cit; p.230.
[4406] Z. Sardar: *Explorations in Islamic Science*; op cit; p. 85.
[4407] O.A. Farukh: *The Arab Genius*; op cit; p.35.

maintain social balance in society and promote the values of the world-view of Islam.[4408] Thus, medicine, for instance, dealt with health and hence was a worthy science in that it preserved their health, and cured their bodies from disease.[4409]

The practice of the faith also imposed and stimulated a zeal for social accomplishments, which impacted considerably on the rise of Islamic civilisation. Ankawi points out how knowledge of the Qur'an and the Sunna (Islamic tradition) dictate to a Muslim how to behave vis a vis others, how to help, how to do such a thing, or how to establish schools and hospitals, thus, proving Islamic social conscience and dimension.[4410] Anne Marie Edde gives many instances such as that of the physicist Al-Humsi who refused to take any payment for curing people, and who was forced to accept a salary at hospital.[4411] Another Al-Dahwar earned 1500 Dinars a year, and became so wealthy, he founded a madrasa which he endowed with a waqf.[4412] Others such as Amin al-Dawla bought books and constituted a library of 20 000 books.[4413] The concept of the public library itself owes its inception to the fact that the library mosques were the first libraries in Islam, the custom among Muslims being to deposit in the mosques copies of the Qur'an and works of jurisprudence.[4414] Mosques soon collected works bequeathed and donated by scholars, and many scholars made wills to the effect that some of their books or entire libraries should be donated as waqf to the mosque of their village or town; caliphs and rulers, following suit, donated valuable works to the mosques.[4415]
Durant outlines further the links of faith with social progress, how Islam promises worldly success to good Muslims; punishment for lying or cheating merchants; denouncing monopolists, and speculators who 'keep back grain to sell at high rate' and bade the employer 'give the labourer his wage before his perspiration dries.'[4416] The Prophet of Islam was known to

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[4409] O.A. Farukh: *The Arab Genius*; op cit; p.35.
[4410] Prof Ankawi during discussion session in: *Islam and the Medieval West*; K. I. Semaan; ed; op cit; p. 159.
[4411] Anne Maried Edde: Les Medecins dans la Society Syrienne du 7em au 13em siecle: *Annales Islamologiques, Institut Francais d'Archeologie du Caire,* Vol 29; pp 91-109; at p. 98:
[4412] Ibid.
[4413] Ibid.
[4414] A.L.A. Ibn Dohaish: Growth and Development of Islamic Libraries; in *Der Islam*, vol 66; pp.289-302. p.290.
[4415] Ibid; pp.290-1.
[4416] W. Durant: *The Age of Faith*, op cit; p.180.

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[4412] Ibid.
[4413] Ibid.
[4414] A.L.A. Ibn Dohaish: Growth and Development of Islamic Libraries; in *Der Islam*, vol 66; pp.289-302. p.290.
[4415] Ibid; pp.290-1.
[4416] W. Durant: *The Age of Faith*, op cit; p.180.

heap praise upon those who, far from being parasites, enrich themselves so as to be able to help the deprived.[4417] The Muslim, Scott says, mindful of the Qura'nic precept, which inculcates industry as a virtue and stigmatises idleness as a crime, was the most laborious and successful of agriculturists, the most skilful of artisans.'[4418] In Africa, as Smith points out, as soon as Islam is embraced, sorcery, with its attendant evils, gradually dies away; human sacrifice becomes a thing of the past. Squalid filth is replaced by personal cleanliness; hospitality becomes a religious duty; drunkenness, instead of the rule becomes a comparatively rare exception.[4419] Idleness henceforth degrades, and industry elevates.[4420]

Acting under the ethos of the faith, medieval Muslim rulers, despite their shortcomings, were responsible for some of the greatest feats of learning. The role of al Ma'mun in the early 9th century, as an enthusiastic patron of the scientific activity in Baghdad, is paralleled by that of al Hakem II a century later in Cordoba. Al-Hakem sent emissaries to Egypt and Iraq, among other Muslim countries, in search of books, and built one of the largest personal libraries in history. He also employed copyists to duplicate rare manuscripts and generally encouraged scholars in all sciences.[4421] Al-Mamun (r. 1043-1073), the penultimate Berber ruler of the Banu Di Nhun dynasty (11th century) of Toledo was surrounded by a crowd of scholars who acted as his viziers and advisers, or whom he directly sponsored. The historian Al-Higari says:

> 'There never was amongst the Reyes of Taifas a ruler as powerful and as famed as him (Al-Mamun). In his Majlis (council) were gathered Muhammad B. Saraf, a glory of al-Qayrawan, Abd. Allah B. Khalifa al-Misri, al-Hakim, Abu' Farraj al-Baghdadi al-Adib, and amongst his viziers were the scholars: Abu Isa B. Labbun; Ibn Sufyan; Abu Amar b. al-Farrag, and Abu'l Mutarrif b. Mutanna.'[4422]

Al-Moktadir, King of Saragossa, was renowned for his erudition, and for his knowledge of philosophy, geometry and astronomy, whilst Al-Modhaffer, king of Badajoz, compiled a great encyclopaedia.[4423] The Seljuk Turks surrounded themselves and sponsored countless scholars

[4417] M. Hamidullah in M. Rodinson: *Islam and Capitalism*; op cit; p. 21.
[4418] S.P. Scott: *History*; Vol II, op cit; p.219.
[4419] R.B. Smith: *Mohammed*; op cit; pp. 42-3.
[4420] Ibid.
[4421] A. I. Sabra: The Scientific Enterprise; op cit; at p.190.
[4422] E. Teres: le Development de la Civilisation Arabe a Tolede; in *Cahiers de Tunisie*, vol 17-8; 1969-70; pp. 73-86. p. 79.
[4423] S.P. Scott: *History*; Vol 3; op cit; p. 430.

(Omar Khayyam, Al-Khazini, etc), and some of the best works and accomplishments were made in their courts, such as those accomplished by the astronomer, instrument maker, Al-Usturlabi, who compiled tables for the Seljuk ruler Mugith al-Din Mahmud (ruled 1117-1131),[4424] and who also named his famous comprehensive instrument after the Seljuk patron and Vizier Ibn Khalid (d. 1138).[4425]

The founding of institutions of learning and other social institutions was generalised amongst them. Thousands of learning institutions: madrasas, libraries, scientific academies, etc, were set up. At the end of the 9th century, under the Aghlabid rulers, a Bayt al-Hikmah (House of Wisdom) was established in al-Qayrawan rivalling its counterpart in Baghdad in the study of medicine, astronomy, engineering and translation.[4426] Tens of hospitals were erected: the construction of a hospital was generally regarded by Muslim rulers as one of the most pious deeds.[4427] The many madrasas and hospitals Ibn Jubayr saw in his travels across the Islamic world were described by him as 'the finest proofs of the glory of Islam.'[4428] Rulers (like wealthy citizens) gave their financial support to students and those who dispensed learning. The Mamluk prince, Yalbagha al-Umari, for instance, ordered that each student at the mosque of Ibn Tulun (Cairo) be given forty dirhems every month;[4429] whilst Husam al-Din Lajin paid salaries for professors and stipends for students.[4430]

Emulating the examples of the caliphs, the governors of provinces vied with their royal masters in the propagation of knowledge.[4431] They founded schools and academies; offered prizes for new and useful discoveries, and at their invitation, the greatest scholars in their jurisdiction assembled once a year at the seat of government, for public discussion of subjects of interest to the learned professions, or of such as could, through the medium of practical inventions, be made to ensure the

[4424] G. Sarton: *Introduction*; op cit; vol 2; p. 204.
[4425] F. Rosenthal: Al-Asturlabi and al-Samawal on Scientific Progress; *OSIRIS*; vol 9; 1950; pp. 555-560.
[4426] M al-Rammah: The Ancient Library of Kairaouan and its methods of conservation, in *The Conservation and preservation of Islamic manuscripts*, Proceedings of the Third Conference of Al-Furqan Islamic Heritage Foundation (1995), pp 29-47, at p. p. 29.
[4427] P. Lory: Philosophes et Savants; with participation of H.Bellosta; in *Etats, Societes*; op cit; pp. 371-98. p.387.
[4428] Ibn Jubayr, Vol 3, p. 330 In F. Michaud: The Scientific Institutions; op cit; p. 999.
[4429] Al-Makrizi, Ahmad Ibn Ali. *Al-mawaiz wa Alitibar fi dhikr al-Khitat wa-Alathar*. Edited by Ahmed Ali al-Mulaiji. 3 Vols, (Beirut: Dar al-Urfan, 1959), Vol 3, pp: 222-3.
[4430] J. Berkey: *The Transmission of Knowledge in Medieval Cairo* (Princeton University Press, 1992), pp 52-4.
[4431] S.P. Scott: *History*; op cit; vol 3; p. 464.

benefit of the community.[4432] And, wonder of the time, possibly unique in the history of Muslim lands, such rulers showed great tolerance for the activity of the scholars, supporting an elite of open minds, and allowing teaching to take place 'in a climate of great freedom.'[4433]

Finally here, and most importantly, Islam spurred learning, knowledge, civilisation, society and economy in a manner Muslim society never did since, at the very source and in their very essence: the search for perfection. The Qur'an is perfection in every respect, and it constantly stresses the search for excellence and perfection in respect to each and everything. Performing prayers demands from the person the perfect approach, in mind, in hygiene, in its performance, and when in group in alignment, movement, behaviour, etc. Timing and direction of prayers have also to be perfect. And so it goes for every single aspect of the faith, whether fasting, alms giving, reciting the Qur'an, going on pilgrimage, dividing inheritance... This constant demand for perfection shapes and affects everything, especially as in Islam, faith and deeds, whatever their nature, are one and continuous, and daily. This explains so much of what we have in early Islamic civilisation approaches the perfect, from the elaboration of the sciences and the design of the arts, to the manufacturing of glass and paper, to the management of libraries and hospitals, to the erection of gardens and irrigation works, to that of observatories and scientific academies, to the construction of whole towns and cities, and to the building of dams, the latter, designed and constructed with such skills as to function to this day in Spain. And for anyone seeking such perfection effortlessly, all that is needed is a gaze at the decoration or design of buildings from that era. No further evidence would be needed after that.

[4432] Ibid; p. 465.
[4433] F. Michaud: The Scientific Institutions; op cit; p. 994.

3. 'Islamic Orthodoxy' as a Cause of Decline:

If Islam is deemed a hurdle to sciences and progress, Sunni Islam, Orthodox Islam as it is often called, 'a dark, intolerant, fanatical side of Islam,' is deemed by Western scholarship as the main culprit in the collapse of Islamic civilisation. Hence, for Von Grunebaum:

> 'During the great age of Islam, Greek philosophy and Greek science had battered the walls of Orthodoxy. Every advance in thought, in insight into the ways of nature, every effort devoted to acculturating and developing the offerings of classical antiquity…,' However, once Orthodoxy came about:
>
> 'The sciences receded under the suspicion of heresy. The government made ready to lend an arm to the orthodox reaction and assisted it through education and repression. What had been the caution of traditionalism became the rigor and fear and soon of death. The period knew that it was sterile and declining. Literary formalism and intellectual rigidity were to accommodate the unlettered… and a return to the demonical world and magic.'[4434]

For Hamarneh (a Western based Arab scholar):

> 'I personally believe that religious fanatics and reactionary elements within the Muslim society are to be blamed for the most part for retardation in high calibre achievements. They withstood and restrained free thought and interpretation of natural phenomena based on personal observation and experimentation and not on blind tradition. Bigotry and religious blindness hindered many from becoming original investigators and curtailed genuine productivities of others from reaching the heights of authentic contributions and remarkable discoveries-heights to which they aspired if freedom of expression was secured. A case in point was the taboo imposed on human dissection to promote and expand true knowledge of human anatomy. Another was the opposition to any idea, interpretations, or doctrines which might jeopardise Hippocratic religious faith, based on unrealistic, biased Muslim concepts. And finally there was the blind reverence to ancient legacies and traditions, to the extent of paralysing new ideas and innovations.'[4435]

[4434] G. Von Grunebaum: *Islam*; op cit; at pp. 28-9.
[4435] S.K. Hamarneh: *Origins of Pharmacy and Therapy in the Near East* (The Naito Foundation; Tokyo; 1973) p. 126.

This Orthodoxy, which supposedly destroyed Islamic civilisation, is said to have risen with the incoming of the Turks, the Berber Almoravids and Almohads in Spain, and with Al-Ghazali and his predecessor: Al-Ashari. These are the orthodox, the antithesis of the liberal Fatimids, the harem lover kings of the Taifas, and dissolute Abbasid Caliphs, who it seems, in their dissolution and depravity, were the reason why Islamic civilisation thrived. Hence, for Renan:

> 'The reason why Islamic science succeeded in the first centuries was because Islam was then less fanatical and less organised; however, once its destinies fell into the hands of the Tartar (Turks) and Berbers, dour races, brutal and devoid of intellect, its fortunes changed... Indeed, the first Arabs, who followed Islam, hardly believed in the mission of the Prophet. During two centuries disbelief in Islam was general. Then came the rule of absolute dogma, which was only surpassed by the Spanish Inquisition.'[4436]

For Briffault:

> 'The attitude of religious ardour towards intellectual culture was precisely the same in the Muslim as in the Christian world. Only there was this difference, that in the former it was the intellectuals, and heretics who for a time held the whip-hand of power; the pious had perforce to rest content with sour looks and suppressed growls, and to wait patiently until the Turk, the Berber, and the Spaniard came to their assistance, and plunged Islam back into the purity of faith and the darkness and ignorance of barbarism.'[4437]

This consensus amongst writers on Islamic civilisation that Islamic Orthodoxy destroyed the civilisation, on close scrutiny, however, shows a large trail of contradictions and historical errors, too obvious to be missed by any historian ready to assess such theories without any preconceptions. The first source of criticism of these historians arises with their timing of Islamic orthodoxy.

[4436] E. Renan: *L'Islamisme*; op cit; p. 955.
[4437] R. Briffault: *The Making of Humanity*; op cit; pp. 217-8.

a. The Timing of Orthodoxy:

It is a challenge for anyone to come up with anything that makes sense when looking at these historians' timing of the destructive impact of Islamic Orthodoxy as seen in the following.

Islamic orthodoxy and its dire consequences on Islamic civilisation is first traced to the 9th century, as by Multhauf, who says:

> 'Abbasid metaphysical toleration began to break down under the caliph Mutawakkil (847-61) who backed the Orthodox Sunnite sect against Muslim liberalism.'[4438]

Or Ameer Ali (a Western historian, probably E.G. Browne, with a borrowed Muslim name),[4439] who writes:

> 'A cruel drunken sot, almost crazy at times, al-Mutawakkil made an alliance with the latter party (with the Orthodox),' and so took place 'the expulsion of the party of progress from their offices under Government. The colleges and universities were closed; literature, science and philosophy were interdicted, and the Rationalists were hunted from Baghdad.'[4440]

Then, Sarton, who says that:

> 'The great toleration shown to non Muslims by the early Abbasid caliphs, and especially by al-Mamun and al-Mutassim, came to a sudden end under al-Mutawakkil (847-861), who approved himself a fanatical champion of Sunnite orthodoxy and persecuted with equal cruelty the people of other faiths and the Mu'tazila, that is, the liberals, of his own faith. Yet al-Mutawakkil continued to protect men of science, chiefly the physicians, and he encouraged the school of translators headed by Hunain ibn Ishaq.'[4441]

Sarton, rightly, or cleverly, avoids accusing Islamic Orthodoxy of banning science, for he knows very well, that thousands of scientists thrived under this so called Orthodoxy. But Sarton remains the lone figure. Unlike him, Wiet et al hold:

[4438] R.P. Multhauf: *The Origins of Chemistry*; op cit; p.123.
[4439] Indeed, the style of writing is definitely not that of a Muslim, nor is the terminology used such as 'Arabian,' 'Saracen,' 'the faith of Mohammed,' etc. The admiration for aspects of Muslim civilization is shared with Browne, and the onslaught on Sunni Islam, al-Mutawakkil, Al-Ashari, the Seljuks, found in Ameer Ali and Browne is absolutely identical in both argumentation and style.
[4440] Ameer Ali: *The Spirit of Islam* (Methuen; London; first printed 1922; 1967 ed), pp. 439-40.
[4441] G Sarton: *Introduction;* vol I, op cit; p.583.

> 'The Moslem community rejected Kindi's (801-73) philosophic system as heresy, since it ran counter to Orthodoxy on three major tenets of faith: the creation of the world, Providence, and the resurrection of the body.'[4442]

Which contradicts what these very authors (Wiet et al) had said in a previous chapter:

> 'In the literary world, as in politics, the Persian fashion now prevailed. This ninth century was, for Mesopotamia and Persia (thus in the time and place of al-Kindi), a period of splendour. We witness the unfolding, under the stimulus of outstanding rulers, of a rich cultural and scientific literature and a high artistic flowering. Arabic translations of the main philosophic and scientific works of antiquity were made and, under this influence, Muslim theologians, unable to remain aloof, were forced to evince an interest in the relation between reason and religion.'[4443]

From the 9th century, the destructive timing of Orthodoxy is then moved to the early 10th century under the aegis of Al-Ashari. Al-Ashari (b. in Basra in 873-874-d.935-6) belongs to one of the oldest Arab families. At first a Mu'tazilite, he was reconverted to Sunnite 'orthodoxy' in 913 and henceforth devoted his work to its rationalization and defence. He may be called, according to Sarton, the founder of Muslim scholasticism, and re-established theological unity and 'orthodoxy.'[4444]

On al-Ashari's impact, Wiet et al (who have already told us that Orthodoxy killed Islamic civilisation in the 9th century):

> 'His (Ashari) ideas were seized on by the pious bigots, and it was this group that precipitated the decline of Islamic intellectual life. Its pietist rigour could lead nowhere but to the enslavement of thought; its ideas were imposed on the believer in the form of a catechism.' [4445]

Multhauf, who also has already placed Islamic Orthodoxy in the 9th century, also moves it forward to coincide with Al-Ashari (and al-Farabi). He says:

> 'An Orthodox and anti intellectual reaction gained momentum in Baghdad during the lifetime of al-Farabi (b.ca 870; d. Damascus 950), and the great philosophers of Islam subsequently appeared elsewhere.'[4446]

[4442] G. Wiet et al: *History;* op cit; p.556.
[4443] Ibid; pp.156-7.
[4444] G Sarton: *Introduction*; vol I, op cit; p.625.
[4445] G. Wiet et al: *History*; op cit; p.567.
[4446] R.P. Multhauf: *The Origins of Chemistry*; op cit; p.120.

For E.G. Browne, the destructiveness of al-Ashari's influence compares to that of Genghis Khan and Hulagu.[4447]

For Ameer Ali (Browne?), Al-Ashari and his followers (such as Ibn Asakir) saw rationalism as heresy, and it is his dogma which arrested the progress of the Muslim nation and paralysed their intellectual energy for centuries.[4448] Because of Al-Ashari, Ameer Ali says:

> 'All questioning was declared to be an impiety and unforgivable sin, whilst the spirit of inquiry was held to be a manifestation of the devil.'[4449]

Thus, if Browne, Ameer Ali, Multhauf, Wiet, and many others who say that Orthodoxy killed sciences and learning in the 9th and 10th century are right, it means that sciences were dead in the land of Islam. Which is historically false, for sciences were thriving in the land of Islam, and the number of scientists who flourished in the 10th century is remarkable as can be read in Sarton's account of the period:

> 'First half of tenth Century: 'the main task of mankind was accomplished by Muslims. the greatest philosopher, al-Farabi, was a Muslim; the greatest mathematicians, Abu Kamil and Ibrahim ibn Sinan, were Muslims; the greatest geographer and encyclopaedist, al-Masudi, was a Muslim; the greatest historian, al-Tabari, was still a Muslim. It is true the greatest physician, Ishaq al-Israili, was not a Muslim but an Arabic speaking Jew. It is interesting to note that Ishaq, born in Egypt, practiced in Tunis.'[4450]

There was also:

> 'A strong Arabian group: al-Hamdani, Abu Dulaf, abu al-Faraj al-Isfahini, Ibn Duraid. The Persian group was not quite as strong, yet considerable: Ibn Rusta, Ibn al-Faqih, Abu Zaid; Abu Bakr al-Razi: a Spaniard; Al-Balkhi and al-Jaihani came from Khurasan and Transoxiana; al-Farabi and Ibn Amajur were Turks! Thus was Muslim culture the highest of those days, stretching from central Asia to the Western end of the world.'[4451]

Hundreds more scientists and scholars of every sort can be added to this list, who all thrived in this period when supposedly Islamic science has been killed by Orthodoxy, and these include: Al-Battani (850-929); Al Sufi b.903-d.986; Al-Madjusi. d. 994; Al-Majriti d. 1007; Ibn al-Nadim. (d.955); etc.

[4447] E.G. Browne: *Literary History of Persia*, vol I (1908), p. 286.
[4448] Ameer Ali: *The Spirit*; op cit; pp. 441-ff.
[4449] Ibid. p. 443.
[4450] G Sarton: *Introduction*; op cit; vol I, p.624.
[4451] Ibid.

Another group of historians, and the timing of Orthodoxy's destruction of Islamic science is moved forward once more. Artz, for instance, says that:

> 'By the eleventh century, the greatest days of Islamic letters and learning were over.'[4452]

This is again historically untrue. Sarton tells us about this first half of 11th century:

> 'To come back to the period under consideration, it would not be too much to say that it marked the climax of medieval thought. The great leaders were so many-Ibn Yunus, Ibn al-Haitham, Al-Biruni, Ibn Sina, Ali ibn Isa, al-Kharkhi, Ibn Gabirol (all Muslims except the last who was a Jew)-that, for a moment at least, the historian is bewildered.'[4453]

Orthodoxy is then moved to the second half of the 11th century. Wiet et al (once more, after having killed Islamic science twice, already, by this same orthodoxy,) now, say:

> 'These two Ibn Butlan (d. 1063), and Ibn Ridwan (c. 998. c.1061) exponents of free inquiry and discussion should be noted because Moslem thought was soon to be aligned by the Seljuk madrasa along a very much lower level; we notice, not for the first time, the 'lamentable decadence that set in culturally as a result of religious intolerance'. The change did not prevent some personalities of note from emerging, but their isolation is apparent. Science, from being the shared preoccupation of a great number of intellectuals, became, as it were, the prerogative of a special class vowed to pure erudition.'[4454]

The madrasa system, symbol and 'cause' of the decline of Islamic learning in the second half of the 11th century, was set up by the Seljuk Nizam al-Mulk in 1065 and thereafter, and it comes under fierce attack by Wiet and his group:

> 'The madrasa system in particular, as an institution was undoubtedly vitally necessary for ensuring the immediate future of Islam. It was none the less true that one result of it was a decline in the quality of education.'[4455]

And:

[4452] F.B. Artz: *The Mind;* op cit; p. 172.
[4453] G Sarton: *Introduction*; op cit; vol I, p.693.
[4454] G. Wiet et al: *History*; op cit; p.663.
[4455] Ibid; p. 458.

> 'The function of the madrasa was a double one; it served both as a large seminary, turning out religious personnel-imams, cadis, muftis-and as a training-ground for higher administrators. Thanks to this twofold nature of the institution, Islam became no longer simply a religion but also the strong political and moral support of a whole society. It was paradoxical that the foundation and proliferation of the madrasas should at the same time have entailed a decline in educational standards.'[4456]

And:

> 'Following the extension of the madrasa system, however, religion began to exert an inimical influence on intellectual enquiry .' There was nothing,' writes Father Abd al-Jahl, 'not even the establishment of a state-organized educational system, hitherto non-existent, which did not contribute to the general ossification. Creative intellectual endeavour was stifled by the creation of universities in Baghdad and elsewhere, which were intended to foster it.'[4457]

Multhauf, whose Orthodoxy has killed Islamic science twice, already, now also moves such orthodoxy forward to the mid 11th century:

> 'Shortly after Avicenna's death (in 1037) the wave of orthodoxy spread over Persia and Avicena's mode of philosophising disappeared.'[4458]

Von Grunebaum agrees:

> 'The tendency natural to despotism and orthodoxy to discourage revision and reform... are responsible for Islamic civilisation to look like a torso. Arrested in its growth during the 11th century, it has remained an unfulfilled promise.'[4459]

And so does Bernal:

> 'After the eleventh century, although there was no spectacular collapse, it is evident that the best days of Islamic science were over;'[4460]

and, further on, insisting:

> 'Science in the Islamic world remained substantially frozen at the stage it had reached in the eleventh century. The ostensible reason

[4456] Ibid.
[4457] Ibid.
[4458] R.P. Multhauf: *The Origins of Chemistry;* op cit; p.123-4.
[4459] G. Von Grunebaum: *Medieval Islam*; op cit; p. 322.
[4460] J.D. Bernal: *Science in History;* in Four volumes (Ca. Watts and Co Ltd; London; 1969), Vol 1; p.281.

for this was the rise of the clerical faction which actively discouraged philosophy and science.'[4461]

Thus, it seems, by general consensus, that by the end of the 11th century, Islamic thought and science are definitely over, especially when Wiet and his group warn us:

'Too much attention should not be paid here to the excessive praises showered by historians on the scholars of the twelfth and thirteenth centuries,' who are mere vulgarisers on the whole.[4462]

And yet, again, nonsense and distortions prevail, for in the 12th century and the first half of the 13th century, we find not only some of the greatest names in Islamic sciences, but also some of the most brilliant breakthroughs, when supposedly Islamic sciences had been killed by orthodoxy a century earlier. And here follows a brief sample of such great names, beginning with the botanist Al-Ghafiqi (d. 1165) who wrote *Kitab al-Adwiyat al-Mufradah* (The Book of Simple Drugs), whose immense value has been noted by Meyerhof, in particular.[4463] Yaqut al-Hamawi (d. 1229), who managed altogether 33,180 pages in his two encyclopaedic works: *Mu'jam al-buldan* (Dictionary of Countries) and *Mu'jam al-Udaba* (Dictionary of Men of Letters,).[4464] This work by Yaqut s probably the major reference work we have of Islamic scholarship. Al-Jazari (fl early 13th century in Dyar al-Bakir; Turkey) is the author in 1206 of *Al-Jami Bain Al-Ilm Wal-Amal Al-Nafi Fi Sinat'at Al-Hiyal* (A Compendium on the Theory and Practice of the Mechanical Arts).[4465] This is by far the best medieval work on technology and engineering. Al-Khazini (flourished ca.1115-ca 1130 at Merw now Turkmenistan,) is the author of the *Balance of Wisdom*, which has been the object of focus above. He also dealt with astronomy; mechanics, physics, and mathematics under the patronage of the Seljuk court.[4466] Al-Idrisi (1100-1165,) born in Ceuta, Morocco, received his education in Cordoba, and became the greatest geographer of his age. Ibn al-Shatir of Damascus (d. 1375) anticipated and inspired Copernicus' planetary theories.[4467] Ibn Khalikan (d.1282) was the author

[4461] *Ibid;* p.283.
[4462] G. Wiet et al: *History*: op cit; p.663.
[4463] M. Meyerhof: Esquise d'Histoire de la pharmacologie et botanique chez les Musulmans d'Espagne, in *Al-Andalus*, Vol 3: 1935; pp 1-41.
[4464] Yaqut, ibn-' Abd Allah al-Hamawi, *Irshad al-Arib ila Ma'rifat al-Adib*, also referred to as *Mu'jam al-Udaba*, (Dictionary of learned men,) edit., D.S. Margoliouth (Luzac, 1907 ff); Yaqut, Ibn Abd Allah al-Hamawi, Jacut's Geographisches Worterbuch, ed. F. Wustenfeld. 6 vols (Leipzig, 1866-70).
[4465] Arabic text edited by A.Y. Hassan (Aleppo, 1979).
[4466] Well documented, though, by R.E. Hall in the *Dictionary of Scientific Biography,* op cit.
[4467] See, for instance, V. Roberts: The Solar and Lunar Theory of Ibn al-Shatir, A pre Copernican Model; in *ISIS* 48; 1957, pp. 428-32.

of *Wafayat al-Ayan*,[4468] a major biographic work much relied upon by modern scholarship for anything to do with Islamic civilisation. Ibn al-Baytar (1197-1248), Malaga, Spain, was the author of the largest pharmacological encyclopaedia that has survived to our time. He was the author of several other works which were translated into various European languages, the best known *Kitab-ul-Jami fil Adwiyah al-Mufradah* (Dictionary of Simple Remedies and Food), the most comprehensive encyclopaedic work on simple drugs.[4469] Muhyi l'Din Al-Maghribi (fl Syria and later Maragha observatory 1260-1265), and scholar involved in trigonometry, astronomy, whose treatises include *Risala fi kayfiyyat istikhraj al-juyub al-waqia fi'l-da'ira* (Treatises on the Calculation of Sines). Al-Bitruji (b. Morocco, lived in Seville; d. around 1204, whose '*Kitab-al-Hay'ah*' was very popular in Europe especially after it was translated by the Sicilian based Michael Scot under the title 'On the Sphere.'[4470] Ibn al-Nafis (b. near Damascus 13th century; d. Cairo Dec 1288) studied medicine at the Great Nuri hospital and is the precursor of the modern theory of blood circulation.[4471] Ibn Rushd (Averoes) (1126-1192), born in Cordoba but spent most of his working life in Marrakech (Morocco,) where he died; needless to dwell on his impact. Jabir Ibn Aflah (d. 1145), the first to design a portable celestial sphere to measure and explain the movements of celestial objects, also noted for his work in spherical trigonometry, and correctly asserting that the lower planets, Mercury and Venus have no visible parallaxes.[4472] Al-Marrakushi (Morocco; b. 1185) one of the precursors of modern trigonometry.[4473]

This list of scholars who lived in the 12th and 13th century can be further expanded, thus refuting convincingly the notion that Islamic Orthodoxy killed Islamic science in the 11th century.

Maqbul Ahmad (an Oxford graduate of Muslim origin), in a single paragraph, stretches the life, death, and destructive impact of this orthodoxy over nearly ten centuries. He says:

[4468] Ibn Khallikan: *wafayat al-Ayan wa-Anba Abna al-Zaman* (Maymunyah Press, Cairo, 1888). *Biographical Dictionary*, tr., M. De Slane Duprat (Paris and London, 1843).
[4469] J. Vernet and J. Samso: Development of Arabic Science in Andalusia; in *Encyclopaedia of the History* (Rashed ed), op cit, pp 271-2.
[4470] On the Diffusion of al-Bitruji's ideas see R.S. Avi-Yonah: Ptolemy versus al-Bitruji; A study of scientific decision making in the Middle Ages; *Archives Internationales d'Histoire des Sciences;* 35; 1985; pp. 124-47.
[4471] M. Meyerhof: Ibn Nafis and his theory of the lesser circulation. *ISIS* 23 (1935). Pp.100-20.
[4472] P.K. Hitti: *History,* op cit, p. 572.
[4473] G Sarton: *Introduction;* Vol II; op cit. pp. 505-6.

'…The decline of science and technology was (due) to the antagonistic attitude held by the orthodox towards science and philosophy. Such an attitude had its origins in the early medieval period when Greek philosophy and sciences were studied by the Muslims. It was then argued that the study of philosophy, especially Greek, was un-Islamic as it led to the erosion of the fundamental Islamic beliefs and to heresy. The long drawn out controversies and polemics between orthodoxy and liberal opinion had finally ended with the prevalence of the former over the latter. Again, as the Ismaili philosophy with its origins in Greek philosophy, was increasingly influencing Islamic thought, it was felt necessary to re-organise the educational system with an emphasis exclusively on theology. The Nizamiya College of Baghdad was founded (1062) with an objective to train scholars who would be able to combat the 'heretic philosophers.' In this scheme of education, science and philosophy were assigned a secondary position. In time, the educational system became traditional and static, leaving no scope for originality of thought or scientific enquiry. It spread far and wide in the Islamic world and became a source of traditionalism and dogmatism in education. On the other side, researches in science and technology were left to the scholars interested in them. This progressed as and when the patronage of the rulers became available, but the antagonism of the traditionalists was ever present as an undercurrent, and it exerted its pressure whenever it got the opportunity to do so. Thus, we find that the struggle between traditionalism and liberal thought continued unabated throughout the period from the 12th century down to the 16th century, when it resulted in complete ascendancy of traditionalism which lasted until the 19th century. A similar struggle between the Church and science had ensued in Europe in the medieval period, and finally, with the coming of the Industrial Revolution, the influence of the Church receded and liberal and scientific thought succeeded. In the Islamic society, the reverse had happened. Traditionalism and dogmatism firmly established itself from the 16th down to the 19th century.'[4474]

It is not that Maqbul Ahmad had orthodoxy slay science on at least three occasions, early in the middle ages, in the 12th century, and then between the 16th and 19th century, he also makes a terrible historical mistake, for if it was the industrial revolution (late 18th century onwards), as he says,

[4474] S.M. Ahmad: *History;* op cit; pp. xxxiv-xxxv

which brought the birth of science in the Western Christian world, how can he explain Copernicus, Galileo, Descartes, Boyle, Harvey, Da Vinci, etc, who all lived centuries before the 18th century, and who are credited by Western historians as the fathers of Western renaissance. And if Maqbul Ahmad was right, since Islamic Orthodoxy was itself slain in the 19th century (the time of Western colonisation of Islamic lands), what happened to such Muslim lands, which since the 19th century have been free from such 'evil orthodoxy,' and yet have grown instead many times more backward than ever before. At least, prior to the 19th century, before the 'evil orthodoxy' was slain, Muslims were able to match the Christian West militarily, and were superior to it culturally (literacy, manners, cleanliness, social order and organisation, etc).

Finally, the destruction of Islamic civilisation by orthodoxy is put in the late Middle Ages. Thus, Von Grunebaum (who has told us already that Orthodoxy killed Islamic science in the 11th century), now, says:

> 'From the orthodox viewpoint nothing was lost and perhaps a great deal gained when in the later Middle Ages Islamic civilisation prepared to renounce the foreign sciences that could not but appear as dangerous distractions. The retrenchment of intellectual scope must have seemed a small price to pay for the preservation of the original religious experience. Not only substance but method as well came under suspicion.'[4475]

And Campbell:

> 'The orthodox reaction in the thirteenth century saw the rapid disappearance of speculative thought among the Arabic writers of the West. After the fall of Cordova in 1235 and of Baghdad in 1258, Arabic medicine ceased to give birth to new works. The Moors of Spain, however, still continued to practice under the veil of Christianity.'[4476]

Of course, both Von Grunebaum and Campbell are right in placing the beginning of decline of Islamic civilisation at this point of history. Yet both are misled and misleading with regard to the cause of the decline. Indeed, Islamic civilisation, and Islamic scientific output began to decline from the mid 13th century onwards, dwindling gradually until disappearing permanently some centuries further down. They did so, not because of Orthodoxy, but because between 1219 (date of the first Mongol invasions) and the 1260s, the Muslims lost all the centres where almost all their science and scientists came from. Any person, however lame

[4475] G.E. Von Grunebaum: *Islam,* p.118.
[4476] D. Campbell: *Arabian Medicine*, op cit: p.58.

intellectually, but still honest enough, can check this by looking at what places the Muslim lost in the 13th century, and where Muslim scholars came from, lived or worked. Any person can find, indeed, that between 1219 and 1221, all eastern parts of Ferghana, Khwarizm, Herrat, Bukhara, Samarkand, etc, great places of Islamic learning and sciences, were devastated by the Mongols, every single infrastructure, including schools, libraries, dams, trade centres, was wiped out, and hundreds of thousands of people were slaughtered.[4477] Decades afterwards, the Muslims lost their great centres of power and civilisation in the west permanently: Cordova (1236), Valencia (1238), Seville (1248), and the rest of Spain with the exception of Grenada, adding to the loss of Sicily in the late 11th century. At precisely the same time, in the East, the Islamic centres of learning and civilisation were devastated: Baghdad (1258), Aleppo, Damascus, etc, in 1259-1260. Then, once these places began to recover, they suffered further devastations in the early 15th century (at the hands of Timur the Lame.) No civilisation, even today's most powerful, can survive if all main centres of power and civilisation are lost or devastated by barbarian hordes. Browne, by no means a fervent admirer of the Islamic faith, for instance, talks of:

> 'The awful catastrophe of the Mongol or Tartar invasion of the 13th century, which inflicted on Islam a blow from which it has never recovered.'[4478]

The caliphate was overthrown in 1258, its towns and cities laid waste, and Browne makes the point, that although the surviving scholars of the younger generation carried on the sound tradition of scholarship for a while longer,

> 'there is, broadly speaking, a difference not only of degree but of kind between the literary and scientific work done before and after the thirteenth century throughout the lands of Islam.'[4479]

To conclude on this, and admitting one reasoned like an imbecile, one will ask: how could any Muslim scholar come from Cordova or Seville, the greatest centres of Islamic splendour, when they were no longer in Islamic hands (1236 onwards), but were instead in the hands of Western Christians, dedicated to wiping out all aspects and manifestations of Islamic culture.[4480] How could Bukhara produce another Ibn Sina when it had been burned to the ground in 1220? How could Merw thrive when its schools and libraries had been burnt to the ground, and everyone living in the city

[4477] On the destruction of Islamic trade by Mongols and their successors, see, for instance, W. Heyd: The Levant Trade; op cit.
[4478] E.G. Browne: *Arabian Medicine*; op cit; p. 91.
[4479] Ibid.
[4480] See H. Lea: *The Moriscos*; op cit; . S. Lane Poole: *The Moors;* op cit; etc.

slaughtered in 1221?[4481] How could Nishapur suffer the same fate in the same year, 1221, and then produce an Omar Khayyam, again? How could Baghdad be the capital of learning when in 1258 it had a million of its population butchered, and all its institutions of learning, books and libraries burnt down? How could Damascus and Aleppo thrive again, when they had fallen in 1260 to the Mongols and were devastated, Aleppo, in particular, suffering one of its worst outrages in history? And it was the same all over the Islamic world, from Khwarizm devastated in the years 1219-1221, to Valencia lost in 1238, to Murcia lost in the 1250s, etc. These evident facts, repeated everywhere over during the 13th century, explain the decline of Islamic learning, that came precisely in the wake of such losses and devastation, and any ordinary person can find that out by browsing through history, and make sense, unlike the contradictory, fallacious, inane, not to say idiotic explanations given to us by supposed experts on Islamic history.

To confirm further the inane, fallacious nature of explanations, the following section focuses on these 'Orthodox' figures who supposedly destroyed Islamic civilisation.

b. The 'Malefic Orthodox':

Al-Ashari and al-Ghazali:

As seen, already, it was the supposedly maleficent Caliph al-Mutawakkil (847-861), the champion of Sunni Islam, who, first, destroyed Islamic civilisation. It was clear, though, that Islamic civilisation thrived during and after his time until, as Browne would have it, Al-Ashari (d. 935) inflicted on it the same ravages inflicted by Gengiz Khan and Hulagu.[4482] This is historically false, for, as can easily be examined by any survey of Islamic history, Islamic civilisation reached its peak exactly between the 10th and 12th century, thus for centuries after al-Ashari was supposed to have already destroyed it.
Seeking to resolve this quandary, Sachau widens the net of the destructive Orthodox by holding that:

[4481] E.G. Browne: in W. Durant: *The Age of Faith*, op cit; p.339
[4482] E.G. Browne: *Literary History*; op cit; p. 286.

intellectually, but still honest enough, can check this by looking at what places the Muslim lost in the 13th century, and where Muslim scholars came from, lived or worked. Any person can find, indeed, that between 1219 and 1221, all eastern parts of Ferghana, Khwarizm, Herrat, Bukhara, Samarkand, etc, great places of Islamic learning and sciences, were devastated by the Mongols, every single infrastructure, including schools, libraries, dams, trade centres, was wiped out, and hundreds of thousands of people were slaughtered.[4477] Decades afterwards, the Muslims lost their great centres of power and civilisation in the west permanently: Cordova (1236), Valencia (1238), Seville (1248), and the rest of Spain with the exception of Grenada, adding to the loss of Sicily in the late 11th century. At precisely the same time, in the East, the Islamic centres of learning and civilisation were devastated: Baghdad (1258), Aleppo, Damascus, etc, in 1259-1260. Then, once these places began to recover, they suffered further devastations in the early 15th century (at the hands of Timur the Lame.) No civilisation, even today's most powerful, can survive if all main centres of power and civilisation are lost or devastated by barbarian hordes. Browne, by no means a fervent admirer of the Islamic faith, for instance, talks of:

> 'The awful catastrophe of the Mongol or Tartar invasion of the 13th century, which inflicted on Islam a blow from which it has never recovered.'[4478]

The caliphate was overthrown in 1258, its towns and cities laid waste, and Browne makes the point, that although the surviving scholars of the younger generation carried on the sound tradition of scholarship for a while longer,

> 'there is, broadly speaking, a difference not only of degree but of kind between the literary and scientific work done before and after the thirteenth century throughout the lands of Islam.'[4479]

To conclude on this, and admitting one reasoned like an imbecile, one will ask: how could any Muslim scholar come from Cordova or Seville, the greatest centres of Islamic splendour, when they were no longer in Islamic hands (1236 onwards), but were instead in the hands of Western Christians, dedicated to wiping out all aspects and manifestations of Islamic culture.[4480] How could Bukhara produce another Ibn Sina when it had been burned to the ground in 1220? How could Merw thrive when its schools and libraries had been burnt to the ground, and everyone living in the city

[4477] On the destruction of Islamic trade by Mongols and their successors, see, for instance, W. Heyd: The Levant Trade; op cit.
[4478] E.G. Browne: *Arabian Medicine*; op cit; p. 91.
[4479] Ibid.
[4480] See H. Lea: *The Moriscos*; op cit; . S. Lane Poole: *The Moors;* op cit; etc.

slaughtered in 1221?[4481] How could Nishapur suffer the same fate in the same year, 1221, and then produce an Omar Khayyam, again? How could Baghdad be the capital of learning when in 1258 it had a million of its population butchered, and all its institutions of learning, books and libraries burnt down? How could Damascus and Aleppo thrive again, when they had fallen in 1260 to the Mongols and were devastated, Aleppo, in particular, suffering one of its worst outrages in history? And it was the same all over the Islamic world, from Khwarizm devastated in the years 1219-1221, to Valencia lost in 1238, to Murcia lost in the 1250s, etc. These evident facts, repeated everywhere over during the 13th century, explain the decline of Islamic learning, that came precisely in the wake of such losses and devastation, and any ordinary person can find that out by browsing through history, and make sense, unlike the contradictory, fallacious, inane, not to say idiotic explanations given to us by supposed experts on Islamic history.

To confirm further the inane, fallacious nature of explanations, the following section focuses on these 'Orthodox' figures who supposedly destroyed Islamic civilisation.

b. The 'Malefic Orthodox':

Al-Ashari and al-Ghazali:

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Seeking to resolve this quandary, Sachau widens the net of the destructive Orthodox by holding that:

[4481] E.G. Browne: in W. Durant: *The Age of Faith*, op cit; p.339
[4482] E.G. Browne: *Literary History*; op cit; p. 286.

> 'But for al-Ashari and Al-Ghazali the Arabs might have been a nation of Galileos, Keplers, and Newtons.'[4483]

This only ends up creating further problems, for Al-Ashari (d. 935) and Al-Ghazali (d. 1111) belong to two completely different periods of history, separated by nearly two centuries. If al-Ashari had killed science by 935, it should be dead by the time of Al-Ghazali two centuries later. If it lived between the two men until it was killed by al-Ghazali, it means Al-Ashari never killed it in the first place. And, indeed, the number of scientists and scientific accomplishments between the two men, as seen in the previous part, is staggering. Equally staggering is the number of scholars who lived after al-Ghazali (as listed above.) Thus, neither man killed learning.

Sachau, moreover, is completely wrong in holding that Muslim science did not produce scholars of the calibre of Newton, Kepler, and Galileo, stipulating by this that Muslim science is of a lesser value. It is very easy for any person to compare the works of Al-Battani, al-Khwarizmi, al-Biruni, etc with Galileo, Kepler, Newton, etc, and see who achieved most.

Sachau, finally, just like others, fails to grasp, that, as is abundantly shown in the preceding chapters, Muslim scientists, directly and indirectly, were the precursors of such 'great figures of the Renaissance.'

Back to Al-Ghazali, who is generally held to be the orthodox in chief, who caused the end of Islamic civilisation with his views and writing. Thus Bernal says that it was difficult to reconcile reason with the Qur'an, although 'pious Muslim scholars certainly attempted to do so' but this was prevented by Al-Ghazali's book, the *Inconsistency of the Philosophers*, which was a warning of the futility of this attempt.[4484] This is the view held by nearly every commentator on Al-Ghazali. Any consultation or reading of Al-Ghazali, however, will show that in no single instance does Al-Ghazali attack, refute, or discourage science and reason. In fact, any reading of Al-Ghazali will prove the complete reverse. Here is Al-Ghazali in his own words:

> 'The second drawback arises from the man who is loyal to Islam but is ignorant. He thinks that religion must be defended by rejecting every science connected with the philosophers, and so rejects all their sciences and accuses them of ignorance therein. He even rejects their theory of the eclipse of the sun and moon, considering that what they say is contrary to revelation. When that view is thus attacked, someone hears who has knowledge of such

[4483] E.C. Sachau translation and edition of Al-Biruni: *The Chronology of Ancient Nations;* 1879; Preface; p. 10.
[4484] J.D. Bernal: *Science in History*; op cit; p. 275.

> matters by apodeictic (empirical) demonstration. He does not doubt his demonstration, but, believing that Islam is based on ignorance and the denial of apodeictic proof, grows in love for philosophy and hatred for Islam.
> A grievous crime indeed against religion has been committed by the man who imagines that Islam is defended by the denial of the mathematical sciences, seeing that there is nothing in revealed truth opposed to these sciences by way of either negation or affirmation and nothing in these sciences opposed to the truths of religion. Mohamed (PBUH) said: 'The sun and the moon are two of the signs of God; they are not eclipsed for anyone's death nor for his life; if you see such an event, take refuge in the recollection of God (most high) and in prayers.' There is nothing here obliging us to deny the science of arithmetic which informs us specifically of the orbits of sun and moon, and their conjunction and opposition.'[4485]

More than any scholar of Islam, in fact, Al-Ghazali repeatedly insists on the primacy of reason, that reason, with its powers of criticism and appraisal, can correct the data of the senses and imagination: reason alone is able, for instance, to prove that a star is far bigger than it seems to the naked eye, and if imagination fails to provide us with a reliable evaluation of something, reason can.[4486] This comparison between the inadequacy of the senses and the capability of reason is something al-Ghazali insists on more than once. In *Mishkat al-anwar,* for instance, he concludes from such comparison that reason, in contrast to perception, can be aware of the infinity of number, and is also capable of self awareness and self criticism.[4487]

Contrary to widely held assumptions, at no point does al-Ghazali use faith to undermine reason, his view in fact marrying the two, reason bringing us close to the deepest secrets of religion, and the light of faith strengthening reason with its moral task.[4488] Repeatedly, in different works, Al-Ghazali asserts that the facts of faith require rational understanding:

> 'Reason is like the power of sound vision which sees well, and the Qur'an is like the sun irradiating light everywhere... hence reason with revelation is light with light.'[4489]

[4485] W.M. Watt: *The Faith and Practice of al-Ghazali* (London; 1953), pp. 33-5.
[4486] Al-Ghazali: *Mi'yar al-ilm*; pp. 62-5 in A.N. Diyab: Al-Ghazali: in *Religion, Learning and Science in the Abbasid Period;* (Ed by M.J.L. Young et al); op cit; pp.424-44; p. 432.
[4487] Al-Ghazali: *Mishkat al-anwar;* pp. 42-9; Diyab: 432.
[4488] N. Diyab: Al-Ghazali; op cit; p.431.
[4489] Al-Ghazali: *Iqtisad;* 3; *Ihya al-Ulum,* iii; p. 17; in A.N.Dyab: p.431.

The only instance, in the whole of Al-Ghazali's writing, as can easily be verified, where he opposes a 'science' of his time, is his refutation of astrology. His argument is that astrology is condemnable in itself because it seeks to scrutinise the hidden designs of God, and also for three other fundamental reasons:
-It takes away from the believer his sense of responsibility, blaming on the stars his own deeds whether with regard to good or ill that affects him.
-It is based on pure conjuncture, that cannot be verified and that is arbitrary.
-It brings no benefit, whether material or spiritual to the Muslim.[4490]

Another common fallacy about Al-Ghazali is promulgated by Watt who insists that because of Al-Ghazali, there was no great Muslim scholar following Ibn Sina (d.1037);[4491] Al-Ghazali's views, according to Watt, acting as some sort of death warrant on free thought after Ibn Sina. Watt, however, a page before, also says that al-Ghazali in his *Tahafut al-falasifa* (the Inconsistency of the Philosophers):

> 'Is also interested in showing the extent to which some of the sciences of the *falasifa*, such as mathematics, had nothing in them contrary to Islamic doctrine and so could be accepted.'[4492]

Watt thus contradicts himself from one page to the other. On the previous point, he is telling a fallacy that can easily be disproved, for countless scholars thrived after Ibn Sina. The previous part has shown how hundreds such scholars thrived in the 11th, 12th and up to the 13th century, especially in some parts of the Muslim world such as Cairo and Spain.
Watt is responsible for further fallacies. He says that Al-Ghazali 'only killed free thought in the Muslim East,' for in the Muslim West, a century after Al-Ghazali free thought was alive with Ibn Rushd. Seeking to resolve this dilemma of slain free thought in one part of the Muslim world, and living free thought in the other, Watt adds:

> 'Despite his (Ibn Rushd) eminence he had no successors in the Islamic west and was hardly known in the east... he suffered a measure of repression at times from the traditionalists.'[4493]

Here, Watt, just like all Western scholarship holding the same view, is distorting facts on two grounds:
-Firstly, the sharp decline of learning that took place in the East after al-Ghazali, and in the west after Ibn Rushd can be explained by any reader of

[4490] P. Lory (with collaboration from H.Bellosta): Philosophes et Savants; op cit; p.375.
[4491] W. M. Watt: *Muslim-Christian Encounters* (Routledge, London, 1991), p.55.
[4492] Ibid; p.54.
[4493] Ibid; p.55.

history: precisely at the time of Al-Ghazali (d.1111) there descended on the East Christian crusaders (1095-1291) who wiped out Muslims in their millions,[4494] including tens of thousands of Muslim victims in the very hub of Al-Ghazali's scholarship, Jerusalem, which was devastated and its population slaughtered en masse, including its countless scholars.[4495] How could the Muslim East, then, produce philosophers when the land was put to sword and fire, and every Muslim was slaughtered on sight. The scholarship that survived in the East, although considerably diminished, was precisely in the parts that remained free of the crusader scourge, places such as Cairo, Damascus, Aleppo, Mosul, etc...[4496] And when the Muslim East was thoroughly overwhelmed in the 13th century by the combined forces of Mongols and crusaders, it was all too normal for such scholarship to disappear almost completely except in the only place that remained under Muslim control: Cairo.[4497] It is absolutely and precisely the same cause and effect we observe in the Muslim west in the subsequent century when, not long after Ibn Rushd's death (in 1192), during the first half of the 13th century, Spain, with the exception of Grenada, was lost by the Muslims, and Muslims could no longer cogitate under their new Christian masters as they were banned from doing so, besides being expelled, annihilated, etc.[4498]
-Secondly, there is no validity in what Watt (just like the majority of historians) says, that Ibn Rushd was repressed by the Orthodox Berbers, for it is they, as is shown in the following, who sponsored him. Nevertheless, it is now Berbers, who with the Turks, it seems, due to their Orthodoxy, are the source of the woes of Islamic civilisation.

[4494] S. Runciman: *A History of the Crusades* (Cambridge University Press; 1951), Vol I.
Ibn al-Athir: *Kitab al-kamil*; ed K.J. Tornberg; 12 vols (Leiden; 1851-72).
Ibn Al-Qalanisi: *Dayl Tarikh Dimashq* (Damascus, 1983).
[4495] Mudjir Eddin: *Al-Euns al-jalil bi Tarikh el-Qods wa'l Khalil*, translated into French as Histoire de Jerusalem et Hebron, by H. Sauvaire (Paris; Ernest Leroux; 1875; and 1926).
J.W. Draper: *A History*; Vol II; op cit; pp 22-3.
[4496] H. Suter: *Die Mathematike*, op cit.
-L Leclerc: *Histoire de la Medecine Arabe*; 2 vols (Paris; 1876).
[4497] F. Wustenfeld: *Geschichte der Arabischen Aertze und Naturforscher* (Gottingen; 1840).
Baron G. D'Ohsson: *Histoire des Mongols*,.
U. and M.C. Lyons: *Ayyubids, Mamluks and Crusaders, Selection from the Tarikh al-Duwal wal Muluk of Ibn al-Furat*; 2 vols (W. Heffer and Sons Ltd, Cambridge, 1971).
[4498] H.C. Lea: *The Moriscos of Spain* (Burt Franklin; New York; 1968 reprint).
Rodrigo de Zayas: *Les Morisques et le racisme d'etat* (Ed Les Voies du Sud; Paris, 1992).
S. Lane-Poole: *The Moors in Spain* (Fisher Unwin; London; 1888).

The Berbers and Turks:

The blame put on Turks and Berbers in the decline and fall of Islamic civilisation is generalised amongst Western historians. Beginning with Renan, who says:

> 'Here, is according to me the most curious lesson which result from this whole history. The Arab philosophy offers the example, more or less unique of a very high culture suppressed nearly instantly without leaving any traces, and forgotten by the people who have created it. Islamism unravelled in this circumstance what was irremediably narrow in its genius. Christianity, too, had been little favourable to the development of positive science. It had managed to stop in Spain and hinder it in Italy; but did not suffocate it, and even the prominent branches of the Christian family had ended up reconciling themselves with it. Incapable to transform itself, and to admit any element of civilian and profane life, Islam tore out of its bosom every germ of rational culture. This fatal tendency was fought whilst Islam was in the hands of the Arabs, a refined and highly spiritual race, and the Persians, a race that leans strongly towards speculation; but it could not rule since the barbarians (Turks and Berbers) took over the lead of Islam. The Islamic world then entered into a period of ignorant brutality, from which it emerged only to fall into the mournful agony in which it is struggling at present.'[4499]

Likewise, Le Bon speaks of:

> 'The Arab race was very delicate and very indulgent, and never departed from a tolerant spirit. However, when in the thirteenth century, the Arabs disappeared from the scene, and power fell into the hands of Turks and Berbers: 'heavy' races, 'brutal' and 'brainless,' intolerance began to rule amongst the Muslims. It is not doctrines that are intolerant, but men from amongst those entities just cited…Intolerance is the mark of the 'inferior' races: Turks and Berbers.'[4500]

Charles Andre Julien sums up this view, speaking of Turkish impotence and Berber inertia.[4501]

[4499] E. Renan: *Averroes et l'Averroisme,* op cit; p. iii.
[4500] G. Le Bon: *La Civilization*; op cit; pp. 447; 453.
[4501] C.A. Julien: History of North Africa, in L.Valensi: *North Africa Before the French Conquest 1790-1830*; tr. K.J. Perkins (Africana Publishing Company; London; 1977), p. 115.

Putting aside that Orthodoxy rather than the Berbers and the Turks were supposed to have already killed Islamic science many times over by now. This argument that these champions of Sunni Orthodoxy killed learning in Islam is baseless, fallacious, and quite plainly absurd as is shown in the following.

The Berbers:

The Berbers (Almoravids and Almohads, who ruled in Spain from the late 11th to the early 13th century), have raised the outrage of even the keenest admirers of Islamic civilisation:

'Fanatic barbarians, of the eleventh and twelfth centuries,' says Lea.[4502]

For Scott:

> 'The savage instincts of the Berbers were indulged by tortures and all the arts of the most exquisite cruelty. Whenever these barbarians encountered a monastery not one of the holy fathers was left alive. There was now visited upon the Christians a severe retaliation for the unspeakable horrors which they had been in the habit of inflicting upon their infidel adversaries in the name of the Gospel of Peace.'[4503]

Durant notes that:

> 'After Maimonides, the Jews of Spain, fled the Almohad persecution.'[4504]

For Lane Poole:

> 'A New Berber revolution had taken place in North Africa, and a sect of fanatics, called the marabouts, or saints, the Almoravids had conquered the whole country from Algiers to Senegal,'[4505] 'When the Almoravids first came over (to Spain) like a cloud of locusts to devour the country thus offered to their appetite, they found the way perfectly open.'[4506] 'The poets and men of letters who had thriven at the numerous little courts... were disgusted with the savage Berbers, who could not understand their refinements.'[4507]

[4502] H.C Lea: *The Moriscos of Spain;* op cit; p.1.
[4503] S.P. Scott: *History;* op cit; Vol 1; p.584.
[4504] W. Durant: *The Age of Faith*, op cit; Chapter XVII; p.395.
[4505] S. Lane-Poole: *The Moors in Spain* (Fisher Unwin; London; 1888), p.178.
[4506] Ibid.
[4507] Ibid; p.181.

Monroe says:

> 'The Christian threat from without, favoured the development in al-Andalus of a strict Berber orthodoxy unparalleled in the East, as Goldziher already noted years ago,[4508] and this led to intellectual stagnation.'[4509]

George Henri Bousquet speaks of 'the congenital impotence of the Berbers to create anything.'[4510]

And for Fletcher:

> 'The Almoravids were outsiders, people of the Bled, unsophisticated tribesmen, materially and culturally impoverished… It is difficult to imagine Ibn Tashfin at the elegant soirees of the Abbadid court of Seville…. The Almoravid leadership were puritan, ascetic, zealots. They saw their role as one of purifying religious observance by the imposition where necessary of the strictest canons of Islamic Orthodoxy.'[4511]

These assertions, however, are full of contradictions and historical fallacies, though.

In relation to the Almoravids, Mieli first says that in Morocco grew a powerful and fanatical brotherhood, and under the leadership of Yusuf ibn Tashfin constituted an empire which spread from Morocco to Algiers, which killed civilisation and progress.[4512] Then, in the same page, (p.177 bottom of the page) he recognises that: despite its origins, Almoravid domination did not prevent the continuation of science.[4513]

The critics of the Almoravids fail to say that, rather than causing the collapse of Muslim Spain and civilisation, they did the complete reverse, saving it instead. Historians attacking the Almoravids hardly, if ever, tell how the disintegration of Muslim Spain began before the Almoravids, during the rule of the Taifas princes (roughly 1015-1080s), and that such disintegration led to the Christian re-conquest of Spain. Barbastro fell in 1064. Toledo fell in 1085. The rest of Muslim Spain was threatened with collapse. Had it not been for the Almoravid intervention in 1086-89, and their subsequent domination of Spain, the days of Muslim power in Spain

[4508] In a lecture delivered before the Hungarian Academy of Sciences in 1876, and published in Budapest in Hungarian by that Academy in 1877. Spanish tr. F.M. Pareja, 'Los Arabes espanoles y el Islam,' '*Actas del primer congreso de estudios arabes e islamicos: Cordoba* 1962 (Madrid, 1964), pp 3-77.
[4509] J.T. Monroe: The Hispanic-Arabic World, op cit; p. 85.
[4510] G.H. Bousquet: Les Berberes (1957) in L. Valensi: *North Africa;* op cit; p. 115.
[4511] R. Fletcher: *Moorish Spain* (Phoenix; London; 1992), p.108.
[4512] A. Mieli: *La Science Arabe;* op cit; p.177.
[4513] Ibid.

would have ended in the late 11th century instead of the mid 13th century. And had it not been for the Almoravids, Muslim scholarship in Spain would also have ended two centuries prematurely. Islamic scholarship, indeed, ended soon afterwards in these places taken by the Christians, and not retaken from them by the Almoravids. Toledo, once one of the greatest centres of Islamic learning, completely lost such learning as soon as it was captured in 1085 by the Christians, and Muslim scholars, in large numbers, were either slain or fled south to Seville and other places.[4514] Petrus Alphonsi, who had a crucial role in the beginnings of medical and astronomical learning in England, lived in the learned court circle in the Muslim ruled cities of Huesca and Zaragoza, and received a good scholarly education.[4515] When the Christians took Huesca in 1097 and Zaragoza in 1118, Petrus converted from Judaism to Christianity, and left for both England and the North of France.[4516] Many other scholars were either killed by marauding Christian parties, or had to emigrate altogether out of Spain, to Egypt, or as far as Yemen.[4517] It was, thus, Almoravid rule which brought unity and security, and it was under their rule, whether in Spain, or in the Maghrib, that there arose some of the greatest scholars of Islam such as the botanist Al-Ghafiqi (d. 1165), the philosopher and scientist, Ibn Baja (Avempace) (b.1106), the astronomer Jabir Ibn Aflah (d. 1145) etc. Moreover, the great university of Fes thrived under Almoravid rule, and such was the stimulus it provided for the demand for books, it stimulated the progress of paper manufacturing in Fes.[4518] Finally on the Almoravids, their artistic and architectural legacy remains one of the greatest in the history of Western Islam as attested by a number of sources which have studied the subject,[4519] and this fundamentally contradicts the established notion of Almoravid enmity to civilisation.

The Almohads who succeeded the Almoravids in both Spain and North Africa from the mid 12th century onwards are depicted even worse, blamed for the terrible woes they inflicted on Islamic civilisation. Von Grunebaum, Wiet et al, Campbell, etc, all depict the Almohads

[4514] F.F Armesto: *Millennium* (Simon and Shuster; 1995), p.37.
[4515] L. G. Ballester: Introduction; in *Practical Medicine from Salerno to the Black Death;* ed L.G. Ballester et al (Cambridge University Press; 1994), pp. 1-29; note 43 at p.13.
[4516] Ibid.
[4517] C. Dawson: *Medieval Essays* (Sheed and Ward: London; 1953), p. 129.
[4518] A. Pacey: *Technology in World Civilisation;* op cit; p. 41.
[4519] See for instance:
-E. Male: *Art et artistes du Moyen Age* (Paris 1927), pp. 30-88.
-G. Marcais: *Manuel d'Art Musulman* (Paris; 1926).
-H. Terrasse: *L'Art hispano mauresque des origins au 13em siecle* (Paris; 1933).

ferociously for their intolerance and fanaticism.[4520] Which is remarkably odd, for other Western historians tell us the very reverse, that Muslim scholars escaping fanatical orthodoxy in the East found refuge in the West amongst the Almohads. Belonging to the latter group is Artz, who notes that after the 11th century, the 'reactionary orthodox' got the upper hand everywhere except in Spain and North Africa. Here scholars driven from the East found a refuge, just as schismatic and pagan scholars driven out by the Byzantines found refuge with the Muslims.[4521] The Almohads, indeed, proved to be most welcoming to men of science.[4522] The prominent Almohad ruler Abd al-Mumin, for instance, in 1153, summoned Ibn Rushd to Marrakech to organise the local judiciary and educational systems.[4523] It was in Marrakech, the Almohad capital, that Ibn Rushd wrote most of his works on philosophy, theology, astronomy, mathematics and particularly medicine. And equally, there, in Marrakech doctors and philosophers (Ibn Tufayl; Ibn Sabin…) found a warm welcome under the Almohads.[4524] In the Almohad court, especially under the third Caliph, Abu Yaqub, they constituted a sort of corporation presided over by one of them.[4525] Equally, the scholar Ibn Zuhr, after serving the Almoravids, extended his services to the Almohad Abd al-Mumin, and died during his rule.[4526] His son, Abu Bakr Muhammed, was not just a physician of Abu Yaqub Yusuf, but also acted as his vizier. The same prince had also been served by the philosopher Ibn Tufayl, who was also appointed as minister. And when the latter died, Ibn Rushd was appointed in his place.[4527] The Almohad caliphs were also involved in long disputations with scholars,[4528] and Ibn Rushd tells how in private he was able to discuss Greek philosophy freely with the Almohad Emir Abu Yaqub Yusuf, who encouraged him to write his commentaries on Aristotle.[4529] Moreover, just as with the Almoravids, one only needs to look at the arts and civilisation of the Almohads, so fully detailed in many sources,[4530] to realise that if

[4520] See G. Von Grunebaum: *Medieval Islam*; op cit; G. Wiet et al: *History;* op cit; D. Campbell: *Arabian Medicine*, op cit; etc..
[4521] F.B. Artz: *The Mind*; op cit; pp. 151-2.
[4522] R. Landau: *Morocco*: op cit; pp 81-2.
[4523] Ibid; p. 82.
[4524] Ibid.
[4525] G. Deverdun: *Marrakech* (Editions Techniques Nord Africaines; Rabat; 1959), p. 261.
[4526] Ibid.
[4527] Ibid.
[4528] F. Braudel: *Grammaire des Civilisations (*Flamarion, 1987), p.106.
[4529] See George Hourani, *Averroes, 1126-1198: On the harmony of Religions and Philosophy*, E.J. W. Gibb memorial Series (London: Luzac 1961), Vol 21. A Translation, with introduction and notes of Ibn Rushd's *Kitab fasl Almaqal.*
[4530] See for instance:

fanaticism could deliver such achievements, it would be extremely difficult to criticise it. It is to the Almohad that we owe, for instance, the tower of the Kutubya mosque of Marrakech and the Giralda of Seville.[4531] The Giralda, originally 250 feet high, stands 'in perfection,' a four square tower of rosy stone, with a band of turquoise tiles, and crowned with famous 'golden balls' which aroused the cupidity of every invader of the city.[4532] If we also consider the names of scholars who thrived under the Almohads, the list will make fascinating reading. It includes Al-Saqati (d. end of 12th century), Al-Mazini (d. 1170), Al-Ishbili (fl. End of 12th century), Ibn Rumiyya (d. 1239-40), Ibn Baso (fl. Second half of 12th century, who built the Giralda), Al-Bitruji (d. 1204), etc.

In conclusion, those who accuse the Berbers of fanaticism will have to agree whether Muslim 'Orthodoxy' prevailed in the East or in the West. Or far more likely, that the true reason for Muslim scholars running away from Spain to the East was the Christian onslaught on the country, and for Muslim scholars running away from the East to North Africa was to escape Crusader onslaught; and not because of orthodoxy. The dates and circumstances of such fleeing confirm this faithfully, and the stories of surviving and fleeing scholars, as any person can check by reading about their lives, prove it irrefutably.

The Turks:

More maligned than the Berbers are the Turks. And any enemy of the Turks in Islam finds great favour amongst modern historians, as here the Turks' sworn enemies, the Fatimids:

> 'The Fatimid caliphs of Cairo,' [say Wiet et al,] 'lived in magnificent luxury, and writers have written in ecstatic terms about their palaces. Carved wooden panels from these palaces are fortunately still in existence; they are convincing proof of an art which was sure of its techniques, and evinced a true concern for realistic presentation. This justly famous work in wood presents, in cusped medallions which are found all around the Mediterranean, a series of scenes originally juxtaposed, depicting

E.L. Provencal: *La Civilisation Arabe en Espagne* (Paris; 1948).
G. Marcais: *Manuel d'Art Musulman* (Paris; 1926).
H. Terrasse: *L'Art Hispano-Mauresque des origins au 13em siecle* (Paris; 1937).
[4531] W. Blunt: *Splendours of Islam* (Angus and Robertson, London; 1976), p. 61.
[4532] Ibid; pp. 61-2.

hunting, music sessions, dancing, and drinking. The artists from whose imagination they sprang have retained their feeling for balance and systematic disposition. Certain medallions even show groups of animals facing each other, some in postures of gracious repose, but for the most part in well delineated action. (Pl.44b).'[4533]

The rehabilitation of the Turks' enemies goes along with an intense savaging of the Turks as highlighted in a few instances here. Thus, Wiet et al, on the progress of the Seljuks in the 10th-11th century, write:

'For a century and a half the Samanids did battle against the nomad Turks of central Asia. These barbarian tribes had, as mercenaries, swelled the forces of the caliphate.'[4534]

'The nature of the army changed as a result of the constant influx of Turkish mercenaries, recruited from central Asia. Arabs and Khorassians were eliminated and these praetorian guards came to yield a dominant influence, a fact that was profoundly to alter the political balance of power in Islam. These Turks were arrogant and insufferable; they made and unmade caliphs at will, without respect even for their persons.'[4535]

Brockelmann, for his part, equates Turkish 'devastation' with that of the Mongols; the latter only bringing to completion the destruction begun by the Turks, who, 'by centuries of mal-administration inflicted the worst damage on the once flourishing civilisation of Iran and Mesopotamia.'[4536]

Equally, for Artz:

'The striking decline that followed this (Islamic) golden age was due to a number of causes. In the middle of the eleventh century, the backward Seljuk Turks, lately converted to Mohammedanism, took Baghdad and much of the Near East. The Seljuk authorities were repressive against all who did not agree with the orthodox Muslim theologians; in the long and bitter fight of orthodoxy against freedom of thought, the orthodox now, at last, won the upper hand... At the same time the Seljuk could not maintain order; constant revolt and general anarchy, broken rarely by a strong and enlightened ruler, brought devastation, depopulation, and stagnation. Muslim civilization had, from the eleventh century on, something of the same problem of being overrun by

[4533] G. Wiet et al: *History*; op cit; p.790.
[4534] Ibid; p.243.
[4535] Ibid; pp.156-7.
[4536] C. Brockelmann: *History of the Islamic Peoples* (Routledge; London; 1950), p. 240.

inferior cultures that the Roman Empire had had in the fifth century... Only in North Africa and in Spain did the old lights of Islamic learning still burn brightly.'[4537]

And Campbell, who says:

'With the twelfth century, we find the decay of the liberal intellectual activity in Islam. The increasing ascendancy of Turkish races and their intolerance (a characteristic, it must be acknowledged, of most proselytes) was the first cause of the growth of this inhibitory influence among the Muslims....Thus, while ethnic philosophy began to find a home in Latin Europe, the orthodox reaction of Islam reduced the Arabic philosophers and physicians to silence.'[4538]

Chaudhuri, who completely sets aside the fact that homogeneity of the Islamic world was destroyed centuries before the Seljuks appeared on the scene, insists:

'The unity and homogeneity of the Arab world under the Umayyad and Abbasid Caliphates lasted for a long time. But eventually Turkish military expansion from Central Asia destroyed its cohesion.'[4539]

He repeats that the Seljuks caused the fragmentation of the Islamic land after conquering Baghdad in 1055,[4540] yet completely sets aside the fact that they were invited by the Caliph to end the chaotic civil wars that had torn Islam apart for decades before, and to restore unity of the caliphate.

Ashtor goes further in his attacks on the Turks. In his chronological study of the social and economic history of Islam, when reaching the critical period from the late 11th century onwards, that is the period of the crusades, he completely sets aside the impact these crusade wars had, and instead renames the chapter: Feudal Knights and Bourgeois (Chapter VI p. 209 ff.), and then blames all destruction, famines, diseases, and even the decrease of the population (in reality due to the massacres of Muslims by the crusaders) on the Seljuks, as extracts herein highlight:

'The Seljuk feudal lords who tyrannised over their subjects became a rich class; and the government resorted to extortion of its farmers.'[4541]

[4537] F.B Artz: *The Mind*; op cit; pp. 175-6.
[4538] D. Campbell: *Arabian Medicine*, op cit: p.44-5.
[4539] K.N. Chaudhuri: *Trade and Civilisation in the Indian Ocean* (Cambridge University Press; Cambridge; 1985), p.36.
[4540] Ibid; p. 56.
[4541] E. Ashtor: *A Social and Economic History of the Near East in the Middle Ages* (Collins; London; 1976), p. 214.

'The countless passages where the chronicles speak of the tyranny and the cruelty of the Turkish princes leave no doubt to the plight of Oriental townspeople in the Seljuk age. There must surely have been a general decline of prosperity, and as a consequence of misgovernment and poverty was a decrease of population.'[4542]

'The construction of palaces by the new rulers was more than counterbalanced by the destruction of residential quarters. In the first half of the 12th century conditions were very bad and the decline of population was resumed.... Chronicles speak of people leaving their towns because of the tyranny of the governors.... The main reason for the ruin of the towns were not earthquakes, many of which happened in the 12th century, and famines, but the decline of population was mainly due to the misgovernment, and neglect of the public services such as fire services, water supply, and scavenging.'[4543]

'There were many epidemics and diseases throughout the 12th century (which he lists), diseases and epidemics, which happened during the Seljuk rule more than often and were more serious, due to the neglect of water conduits and irrigation canals, which became hotbeds of disease carrying germs, and the general dirtiness were important causes of the deterioration of public health.'[4544]

'The decrease of population was not only a quantitative decline. It was a permanent bleeding or indeed self destruction of the ruling class. Reading the Arabic chronicles carefully one becomes aware of the really catastrophic consequences of the Turkish military of drunkenness.[4545] Innumerable passages deal with the excessive drinking of the princes and their courtiers. Time and again we are told that a prince died as a consequence of too much drinking or was murdered when he was drunk. A prince who abstained from drinking was considered exceptional. Sometimes whole armies were drunk.[4546] Surely the caliphs and other Muslim rulers in former times drank, too, but it seems that in this period it became a more general phenomenon, as far as the upper classes, the elite, are concerned. Undoubtedly the Turks had brought the custom of drinking from their homelands in the cold

[4542] Ibid; p. 217.
[4543] Ibid; p. 218.
[4544] Ibid; p. 220.
[4545] Ibid; p. 221.
[4546] Ashtor quoting out of context Ibn al-Athir: *Kamil,* 12; pp 48; 314; 341.

regions of Central Asia. One consequence was probably rather limited procreation.'[4547]

And, who, according to Ashtor is to blame for bringing the drunkard, devastating Turks in the midst of Muslim civilisation? Muslim theologians and orthodox, he replies.[4548]

More devastating than their Seljuk cousins, it seems, were the Ottoman Turks. Thomas Shaw, after travelling for twelve years through the Maghreb, between 1720 and 1732, came to the conclusion that:

'For many centuries, the Mohametans have strongly neglected arts and sciences, whilst in the past they were the only ones who studiously and successfully kept the learning of philosophy, mathematics, medicine. The errant way of Arab life and the tyrannical manner by which the Turks treat the Moors, do not allow these people to cultivate sciences, which require absolute freedom and tranquillity. The Turks are too much gripped by worry and turbulence, or too attached to their trade and eagerness to enrich themselves, that they have little taste for learning; they even showed me that they were much surprised to see that Christians found pleasure and time to waste so much money for the sake of void speculations, which bring them no profit.'[4549]

Equally, Chevallier D'Arvieux, in his *memoires,* argues that:

'These insolent conquerors had reduced the Arabs to a state which did not allow them to apply themselves to science, despite all the advantages that nature had given them to make extensive progress.'[4550]

Voltaire, in his *Essai sur les moeurs*, incites Catherine of Russia:

'It is not enough to make a happy war against these barbarians... It is not enough to humiliate them, they must be destroyed.' He ends his letter: 'In the name of God beat the Turks. Beat the Turks and I die happy.'[4551]

[4547] Ibid; p. 221.
[4548] Ibid; p. 210.
[4549] T. Shaw: Sciences and arts in Barbary; pp, 338-47; in D. Brahimi: *Opinions et regards des Europeens sur le Maghreb aux 17em et 18em siecles* (SNED; Algiers; 1978), pp 147-8.
[4550] In A. Gunny: *Images;* op cit; p.22.
[4551] Voltaire 1968-79; D15487; 26 February 1769.

In a letter on the same day to Count Vorontsor, he portrays the Turks as enemies of the laws and the fine arts, which are completely unknown to them.[4552]

For Cuper, associate member of the French Academie, in a letter to Galland dated 30 October 1714, the Turks damage statues, and their hostility to the fine arts comes from the Qur'an.[4553] A stigma also extended by Europeans to other subjects of the Ottoman Empire.[4554]

For Chateaubriand:

> 'Unlike the Romans, the Turks never exploit the natural wealth of a country, nor the labour of the conquered populations, instead, all land in the hands of the Turks becomes arid. These invaders belong to the barbarian races in the measure that they destroy everything, and never construct anything. The Turks never plan for the future, never organise the economy, and never seek to preserve anything, instead, they act like vampires, bleeding their victim until it expires, and then they move onto another.'[4555]

And again:

> 'Devastated fields belong to Turks who own three or four thousand olive trees, and who, in a harem of Constantinople devour the heritage of Aristomenes.'[4556]

For Le Bon, writing in 1884:

> 'The successors of the Arabs in Egypt are the Turks. The Turks, although great warriors, who made Europe tremble, and who expanded the influence of Islam, were only powerful militarily. They never achieved any advance in science, trade or arts. And like people who do not progress, they go backward. Fatally the hour of decadence had arrived for them. The end of the Arab civilization in the Orient dates from the day their (the Arabs) empire fell in the hands of the Turks. It is in Egypt that the decline is at its worst. Arts and sciences died with Selim (the Turkish ruler). Corruption and backwardness, and misrule set in. Nobody, today, ignores what is the lot of the regions under the Turks. At the doors of the major cities, even, Smyrne, for instance, brigands rule, and there are pirates even in the seas of the Bosphore and Marmara.'[4557]

Something Von Grunebaum agrees with:

[4552] In A. Gunny: *Images;* op cit; p. 159.
[4553] Cuper referred to in A. Gunny: *Images;* op cit; p.45.
[4554] A. Gunny: *Images*; p.45.
[4555] Abridged from Chateaubriand: *Itineraire*; op cit; pp. 934; 974.
[4556] Ibid. p. 790.
[4557] G. Le Bon: *La Civilisation*; op cit; pp. 460-1.

> 'The Arab countries, especially that had been the centre of Muslim civilisation, submitted apathetically to the twin domination of orthodoxy and the Turks. It was only with Napoleon's expedition to Egypt in 1798 that, through the impact of Europe and the rise of local nationalism in its wake, Muslim civilisation regained the willingness to change, to experiment, to risk, in short, to live.'[4558]

Parry speaks of Turkish fanaticism:

> 'The incursion from the Steppe of another pillaging mounted horde, the Ottoman Turks, quickly converted to Islam and engaged in Holy war against Christendom.'[4559]

As for Isaacs:

> 'By way of conclusion, suffice it to say that the failure of the Ottoman Turks to capitalize initially upon a significant Western medicine and science was due, first and foremost, to the rigid and reactionary attitude of the Ulema. This must be added to other deficiencies: lack of resources, inadequate communications, apathy of administration, and absence of scientific institutions.'[4560]

This persistent labelling of the Turks whether the early Seljuks (10th-13th century) or the Ottomans (13th-20th century) as enemies of science and progress has no basis in reality, but has other motivations. With regard to the Seljuks, hostility to them, just as to the Mamluks, derives from the simple fact that during the Western Christian onslaught on the Islamic land in the crusades era (1095-1291), they were the main foes of the crusaders. Any person reading the history of the crusades, from either sources, Muslim or Christian, old or new, will realise this.[4561] As for the

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[4558] G. Von Grunebaum: *Islam*; op cit; p. 29.
[4559] J.H. Parry: *The Age of Reconnaissance*; p.7.
[4560] H.D. Isaacs: Medicine, Science and Technology: Islamic reactions to Western learning; in *Renaissance and Modern Studies*; Vol 31: pp. 43-57; p.57.
[4561] Ibn al-Adim: *Bughyat al-talab*; partial ed Ali Sevim (Ankara; 1976).
-T.A. Archer: *The Crusades* (T. Fisher Unwin; London; 1894).
-Ibn al-Athir: *Tarikh al-dawla al-Atabakiya Muluk al-Mawsil*; in Recueil des historiens des croisades; 11/ii (Paris; 1871), p. 1-394.
-Ibn al-Athir: *Kitab al-kamil*; ed K.J. Tornberg; 12 vols (Leiden; 1851-72).
-Baha Eddin: Ibn Shadad: *Nawdir asultania;* in Receuil des Historiens Orientaux; III (Paris; 1884).
-C.R. Conder: *The Latin Kingdom of Jerusalem* (The Committee of the Palestine Exploration Fund; London; 1897).
-G.W. Cox: *The Crusades* (Longman; London; 1874).

Ottomans, the same argument holds, for from the 13th until the early 20th century, they were the main Christian military foe, engaging Christendom on countless fronts.[4562] Thus, there is little surprise in coming across such vilification of the Ottomans, vilification which is amply noted by Fisher,[4563] and Davenport, who has also concluded that the Turks, by being the principal Islamic foe of the Christian West for centuries, was the major reason for violent anti Turkish rhetoric.[4564] Galland (1646-1715), has also earlier observed how the Turks were wrongly vilified: it suffices to name them to signify to Europeans a coarse, barbarous, thoroughly ignorant nation.[4565]

The depiction of the Turks as enemies of science and civilisation is furthermore confirmed to be fallacious when historical facts are considered. Beginning with the Seljuks, Talbot Rice, observes that they are generally deemed to have made but little contribution to art, and that the quality of the works produced under their patronage is to be attributed to the fact that they employed Persian, Armenian or Greek craftsmen. But the very distinctive character of Seljuk work, he points out, especially in architecture and sculpture serves to disprove this.[4566] And Talbot Rice gives a very good account of Seljuk artistic accomplishments, with text, and above all, photographs in support,[4567] thus completely refuting the repeated assertion of Seljuk ineptness or enmity to arts and culture. Talbot Rice insists, amongst others, on the search for complicated geometric patterns, which both intrigued and delighted the Seljuk artists, complication that increased with time.[4568] In praise of Seljuk tile works, he also points that it was in Konya that the manufacture of glazed pottery was centred, and it was there, certainly, that the art of setting the tiles reached its highest perfection.[4569] Dwelling on Seljuk woven stuff, he

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-Baron G. D'Ohsson: *Histoire des Mongols,* op cit
-Z. Oldenbourg: *The Crusades*; tr from Fr by A. Carter (Weinfeld and Nicolson; London; 1965).
[4562] A. C. Hess: *The Forgotten Frontier* (The University of Chicago Press, Chicago and London, 1978).
Samuel Chew: *The Crescent and the Rose* (New York; 1974).
P. Coles: *The Ottoman Impact on Europe* (Thames and Hudson; 1974).
[4563] G. Fisher: *Barbary Legend;* op cit.
[4564] J. Davenport: *An Apology for Mohammed and the Koran;* op cit; .
[4565] A. Gunny: *Images*; op cit; p.45.
[4566] D. Talbot Rice: *Islamic Art* (Thames and Hudson; London; 1979), p. 183.
[4567] Ibid; pp 162 ff.
[4568] Ibid; p. 174.
[4569] Ibid; p. 172.

notes, that it was in fact to the Seljuk that was owed the institution of carpet manufacturing in the whole of Asia Minor.[4570]
With regard to sciences, instead of the Turks repressing science, it was the reverse, in fact. A great number of scientists thrived under the rule and sponsorship of the early Turks (Seljuks, Ortoquid etc); names such as those of Omar Khayyam, the mathematician, poet; Al-Khazini (fl ca.1115-ca 1130), famed for his works on the balance, and also for his construction of a sphere showing the earth rotating;[4571] Al-Marvasi (fl.1120), a geographer who wrote on the Far East, China, and Tibet, and also on Zoology;[4572] and al-Jazari (fl in the 12th Century in Dyar al-Bakir), who wrote his book of mechanical devices for his Turkish sponsors.[4573] It was amongst the Turks a rule to sponsor the learned. The Turk Bajkam (mid 11th century) thus, says:

> 'Although I am not capable of scholarship and literary excellence, yet it is my desire that there should not be on this earth a man of letters, or a man of religious learning, or the head of any field of knowledge, but that I have him under my protection.'[4574]

Bianquis makes the relevant point, that until the end of the 11th century, not many Muslims made a living out of their intellectual activity.[4575] Scholars practised other trades which sustained them in their living, receiving very little payment for their works; school masters and copyists of manuscripts, for instance, lived out of this work, but extremely modestly, poorly even.[4576] However, in the 11th century, with the advent of the Seljuk Turks, things changed considerably, thanks to the piety of the Turkish princes and army officers, and also, to considerable measure, thanks to Turkish princesses, and the khans, and waqfs (endowments), which then provided quite good incomes to scholars, and which made possible living in greater comfort thanks to one's science.[4577] Seljuk rulers also sponsored and constructed many scientific institutions, one such ruler, prince Sharaf al-Dawla, in the late 10th century, constructing an observatory in Baghdad, which was fitted with instruments, and was run

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[4570] Ibid; p. 177.
[4571] R.E. Hall: Al-Khazini: *Dictionary of Scientific Biography;* op cit; vol 7; pp. 335-58;
[4572] I.J. Krckovskij: *Izbrannye Socinenja;*.op cit; pp. 363-4.
[4573] See D. Hill: *Islamic Science*; op cit; and *Dictionary of Scientific Biography*; op cit; Vol 7; pp 335-51.
[4574] George Makdisi: On the origin and development of the college in Islam and the West, in *Islam and the Medieval West*, ed. K I. Semaan, op cit; pp: 26-49. p.37.
[4575] Thierry Bianquis: Damas; in *Grandes Villes Mediterraneenes; op cit;* pp. 37-55; p. 44.
[4576] Ibid.
[4577] Ibid.

by a large group of astronomers, including Abu'l Wafa.[4578] Appropriately, no area of the Islamic world is more richly endowed in madrasas than Anatolia, with some 200 surviving examples before 1500.[4579]
Finally, Western historians are baffling with their contradictory views, on one hand blaming the Seljuks for causing the decline of Islamic civilisation by promoting fanatical Orthodox Islam in setting up the madrasa system (Wiet and his group), and then on the other blaming the Seljuks for causing the decline of Islamic civilisation for quite the reverse: indulging in debauchery and poor morality (Ashtor).

The deception in historical writing becomes even more obvious when Ottoman art and culture are examined. Ottoman art, Talbot Rice observes, is wholly original, and distinct, owing in general but little to Persia, and even if the ideas that were to form the basis of Ottoman architecture were adopted from Byzantium, the basic theme was so developed that almost at once it became a distinctive style.[4580] Ottoman achievements in art and architecture, well detailed in some works, also defy the image of Turkish barbarism and enmity to culture, and their consulting them, especially photographic evidence, disproves the countless inanities on Ottoman ineptness or enmity to arts.[4581]
As far as Ottoman support to learning, Galland firmly believes that it is unjust to slander the Turks in this way, and he dismisses the idea that they were inferior to the Arabs and Persians in the sciences and literature common to these three nations. He maintains that they engaged in these pursuits almost from the beginning of the Empire, and that they have an unbroken succession of theologians and legal experts as well as historians.[4582] Galland admires their prodigious quantity of books on Islamic theology, philosophy, physics, mathematics, history, treatises on rhetoric and grammar, poetry in Arabic, Persian and Turkish.[4583] In a letter dated 25 February 1701 to P.D. Huet, former Bishop of Avranches, Galland expresses admiration for the way in which the Turks show their love of good books, spending considerable sums for the acquisition of

[4578] A.Pannekoek: *A History of Astronomy* (George Allen and Unwin Ltd; London; 1961), p. 168.
[4579] R. Hillenbrand: Madrasa, in *Dictionary of the Middle Ages;* op cit; vol 8; pp. 11-12; at p. 12.
[4580] D. Talbot Rice: *Islamic art*; op cit; p. 183.
[4581] O. Aslanapa: *Turkish Art and Architecture* (1971); E. Atil, ed: *Turkish Art* (1980); G. Goodwin: *A History of Ottoman Architecture* (1971).
[4582] In A. Gunny: *Images*; op cit; p.45.
[4583] Ibid; p.46.

manuscripts.[4584] Galland is also struck by the existence of so many poets in Arabic, Turkish and Persian, apparently more numerous than those in other languages. He notices some 1,600 titles, which would occupy more than 2,000 volumes, dealing with Islamic history from the Hijra, the history of the great Muslim conquerors and the biographies of illustrious men in all professions.[4585] Also writing in support of the Turks is another contemporary, Jean de Thevenot, nephew of Melchisedech Thevenot, one of the founders of the Academie des Sciences, who travelled through Turkey, Egypt, Iraq, and India, who describes the beautiful mosques of Istanbul, struck, as he was, by the fact that all these mosques had attached to them hospitals and schools where many poor students, who lacked the necessary means, were fed and taught.[4586] A recently published work also supports the view that, although Muslim science gradually died out in nearly the whole Islamic realm after the 13th century, considerable numbers of scholars, including mathematicians, astronomers, and above all architects, thrived in Turkey.[4587]

c. Inconsistencies of the Orthodoxy Theorists:

The proponents of 'Islamic Orthodoxy' as a cause for the fall of Islamic civilisation, besides distorting historical facts, contradict themselves, in a number of ways.
Beginning with Artz, who again confuses the date of orthodoxy:

> 'By the eleventh century, the greatest days of Islamic letters and learning were over.'[4588]

And then goes on to say:

> 'After the thirteenth century, the conservatives everywhere got control and from then until the nineteenth century no important new intellectual currents developed inside Islam.'[4589]

Then Campbell:

> 'The destruction of the Mongols in Baghdad... the percussion and repercussion of this disaster to Arabic culture found a vibrant cord

[4584] Ibid; p.37.
[4585] Ibid; p.44.
[4586] Ibid; p.13.
[4587] B. Rosenfeld and E. Ihsanoglu: *Mathematicians, Astronomers; op cit.*
[4588] F.B. Artz: *The Mind*; op cit; p. 172.
[4589] Ibid; pp.151-2.

under the reactionary Almohads who were then masters of Moslem Spain.'[4590]

Obviously Campbell is expert on medical matters, but when it comes to history, he ought to have known better. Baghdad, indeed, fell to the Mongols in 1258; by then, the Almohads had been kicked out of Spain.

Wiet and his group tell us:

> 'The Berbers had undergone conversion to Islam without opposition but, equally, without deep feeling. Religion was really of importance to them only so far as it could be made a cover for vague aspirations to autonomy.'[4591]

Then, on the same page, the same lukewarm Berber attitude to religion changes:

> 'The adherence of the Berbers to Islam; their passages of enthusiasm for Kharijite and Shiite ideas, and their final reversion to a rigid orthodoxy.'[4592]

The same authors:

> 'Malekism had made its way into Spain, and there led for a long time an isolated existence, which was peculiarly intransigent and immutable. The atmosphere was not favourable to liberal speculation, and the Spanish Moslem religious tradition was in general restrictive.'[4593]

However, on the same page, they say:

> 'The twelfth century in the West boasts two great names: Ibn Tufail and Averroes. In contrast with the decline of philosophical studies in the East, such studies came now to a fine flowering in Spain.'[4594]

And Von Grunebaum:

> 'Those accomplishments of Islamic mathematical and medical science which continue to compel our admiration were developed in areas and in periods where the elites were willing to go beyond any possibility against the basic strains of orthodox thought and feeling. For the sciences never did shed the suspicion of bordering on the impious which, to the strict, would be near identical with the religiously uncalled for. This is why the pursuit of the natural

[4590] D. Campbell: *Arabian Medicine*: p.45.
[4591] G. Wiet et al: *History;* op cit; p.570.
[4592] Ibid.
[4593] Ibid; p.571.
[4594] Ibid.

> sciences as that of philosophy tended to become located in relatively small and esoteric circles and why but few of their representatives would escape an occasional uneasiness with regard to the moral implications of their endeavours.[4595]

Then, fifty pages down, he notes:

> 'The wealth of new material may have been greatest in medicine and the natural sciences, which had been cultivated.'[4596]

Von Grunebaum's assertion in his first quote (the pursuit of natural sciences being cultivated among relatively small and esoteric circles) contradicts his second one speaking of wealth of material in natural sciences.

Finally, Mieli recurrently dwells on the destruction the Mongols inflicted on Muslim civilisation, and clearly notes the end of Muslim science in Spain following the loss of those great centres of science and civilisation: Cordova (1236), Jaen (1246), Seville (1248), Valencia (1236), Xatiba (1248), Murcia (1253), etc,[4597] then says:

> 'By a curious coincidence, once the Muslims passed on their science to the West, Muslim science and civilisation, now dominated by Orthodoxy, went into irremediable decline.'[4598]

d. Final Words on Orthodoxy:

The decline of Islamic civilisation has nothing to do with Caliph al-Mutawakkil, or al-Ashari, or Al-Ghazali, nor the Berbers or Turks. Anyone consulting any reference work, such as the Dictionary of Scientific Biography,[4599] or Sarton's *Introduction*, will note, that it was in the 13th century that Islamic scientific output fell sharply, especially in the later decades of the century, and not in the time of the Orthodox. When Muslim civilisation collapsed in that century, neither Turks nor Berbers nor Orthodox of any sort were in power in Cordoba, Seville, Valencia, Baghdad, Damascus, Khwarizm, Ferghana, etc. These places in the 13th century were under Mongol and Christian control. These places once

[4595] G.E. Von Grunebaum: *Islam*, op cit; p.114.
[4596] Ibid; p.164.
[4597] A. Mieli: *La Science Arabe;* op cit; p. 178.
[4598] Ibid; p. 246.
[4599] *Dictionary of Scientific Biography*; op cit.

accounted for 95% of Islamic scientific output, so how could Islamic science thrive once they had been lost?

Furthermore, the Berbers and Turks cannot be blamed for the decline of Islamic civilisation for the simple fact that both people had great civilisations and a large number of scholars (as seen in chapter on sciences). Besides, the Turks were in the Islamic land from the 10th century, even from the 9th century (Tulunids in Egypt) and the Berbers from earlier, and civilisation thrived around them and around their time. And if the Berbers were really responsible for the decline of science and civilisation, never should North Africa (their land of origin and settlement) have witnessed any sort of scientific life, whereas it did. North Africa had a fundamental role in the birth of modern and European mathematics and medicine and many other sciences as seen in the previous chapters. Had the Berbers been fanatic enemies of learning, Toledo, which was under Berber rule and domination, would never have become the greatest centre of learning in the 11th century until its fall in 1085.[4600] It is from its libraries, furthermore, that the 12th century translations were carried from Arabic to lead to the Western Renaissance.[4601] Had the Berbers been the fanatical enemies of learning, as generally held, Spain would never have witnessed any upsurge in civilisation under their rule (1088-1248), whereas it did. Jabir Ibn Aflah, for instance, made observations from what the Berbers built, the Giralda of Seville,[4602] and when Seville, once the Almohad capital fell to Fernando III in 1248,[4603] with its fall, precisely, Muslim science died in Spain. Not a single name, not a single Muslim scholar came from that city after its fall to the Christians. Before then, under the Berber Almohads, it was the mighty successor to Baghdad.[4604]

The argument that Orthodoxy caused the decline of Islamic civilisation is further refuted by the fact that Islamic 'Orthodox' practice is based on science. Expressed differently, the stricter the observation of Islam, the more science is required. This is obvious in the sharing of inheritance in complex situations, requiring the most complicated calculations; or in the

[4600] See, for instance,
E. Teres: le Development de la Civilisation Arabe a Tolede; op cit.
J. Vernet: Al-Zarqali: *Dictionary of Scientific Biography;* vol 14.
[4601] C.H. Haskins: *Studies;* op cit.
-C.H. Haskins: *The Renaissance*, op cit.
[4602] W. Durant: *The Age of Faith*; op cit; p.329.
[4603] Ibid; p.697.
[4604] G Sarton: *Introduction,* Vol II, op cit; p.148.

erection of mosques, demanding complex architectural and construction operations to fit with Islamic requirements; or in the strict management of water and soil according to Islamic laws; or in the rigorous writing and application of business contracts and deals and financial transactions, just as the text of the Qur'an demands; or in the arts, which, as stipulated by the faith, demand the utmost ingenuity to avoid reproduction of living forms, and so on and so forth. A practical instance illustrates this in mathematics. The mathematicians of Islam had to perfect trigonometry to solve spherical triangles because Islamic law requires that Muslims face the direction of Makkah when they pray, and to determine the appropriate direction at one's own location requires an extensive knowledge of the solution of such triangles on the sphere of the earth.[4605] The solution of both plane and spherical triangles was also important in determining the correct times for prayers; times which were generally defined in relation to the onset of dawn and the end of twilight as well as the length of daylight and the altitude of the sun on a given day, which all require spherical trigonometry to determine accurately.[4606] Thus, the more Orthodox the practice, the more the need for accurate science, and without science, 'Orthodox' Islam cannot survive. So, contrary to established views that Islamic Orthodoxy destroyed science, Islamic Orthodoxy promoted and created science so as to prevail and thrive, and, above all, promoted science to be strictly faithful to Islam and its rules.

Finally, the argument that Orthodoxy was responsible for Islamic decline can be countered in another way. For centuries, today, Islamic societies have been rid of al-Ghazali and orthodoxy of all sorts. There is no Sunni Orthodoxy in power in any Islamic country at present. Islamic societies are led, instead, by Western minded, secular elites, and this has been the case for decades. Close scrutiny of these Muslim countries, free from orthodox political power, reveals absolutely nothing of worth bequeathed to humanity. The only science that prevails amongst most of them is that of mass murder and mass torture of their own citizens.

[4605] V.J. Katz: *A History of Mathematics (*Addison-Wesley, New York; 1998), p. 274.
[4606] Ibid.

Concluding Words: Islam, Science and Civilisation

The first conclusion, and most obvious, is this: at no other time in their history, and under no other circumstances, have the Muslims achieved anything of similar proportion than in the so called golden era (650-1260). Putting it somehow differently, one can say, that, outside this period, in their whole history, and in all their endeavours, whether scientific, or economic or others, the Muslims never recorded one single achievement of any sort. Prior to Islam, the Arabs lived in the Jahilya, which translates literally as a state of extreme ignorance; when chaos ruled; when girls were buried alive by their fathers, etc. There was no science. On this, at least, every historian, whether lover or hater of Islam agrees: the semi barbarians of the jahilya could in no way compare to the civilised Muslims who came soon after Islam, and this alone is enough to highlight the rise of Islamic civilisation at the same time as the rise of Islam.

-Second conclusion: it is with the break up of the unity and power of the Islamic realm in the 13th century that the greatness of Islamic civilisation faded until this day.

-Third conclusion: the so called Muslim Orthodoxy had nothing to do with this collapse, from near or far as amply shown above.

- Fourth conclusion, Western science and civilisation has its origins in the 'theocratic' Islamic state as is repeatedly shown throughout this work, and demonstrated by other sources.[4607] This happened at the time when the

[4607] J. Vernet: *Ce que la culture doit aux Arabes d'Espagne*, op cit;.
-A. Mieli: *La Science Arabe;* op cit.
-P.K. Hitti: *History of the Arabs* (MacMillan, London, 1970 ed).
-M. Vintejoux: *Le Miracle Arabe* (ed Charlot, Paris, 1950).
-G. M. Wickens: 'What the West; op cit.
-D.R. Hill: *Islamic Science,* op cit.
-J.W. Draper: *A History*; op cit.
-G. Sarton: *Introduction,* op cit.
-C.H. Haskins: *Studies in the History,* op cit.
-R. Briffault: *The Making of Humanity,* op cit.

theocratic Muslim state, so much demonised in historical writing today, promoted science, democracy, and above all respect for human life, values which are all too often not upheld by secular/Westernised Muslim ruling elites of today. It is worth at this point citing Owen, who comments that in the leaders of early Islam, as in the Prophet himself, were examples of men who were eminent for enlightenment, liberality, and toleration, and that the history of Islam, taken as a whole, must be regarded as 'a powerful propaganda of free thought and liberal culture, which is all the more striking when contrasted with the barbarism by which it was surrounded.'[4608]

-The fifth and final conclusion is that of the fundamental difference of timing between Islam and Western Christendom: Western science developed outside a religious framework, just when the power of the Church dwindled (especially in the 17th century onwards;) Islamic science, on the other hand, rose with the faith, and the golden age of Islamic power coincides with the golden age of Islamic science (7th-13th centuries). When the unity of the land of Islam was shattered, science and civilisation died, too, and they are still dead in present orthodox free societies. The proof of this is the number of mathematicians, geographers, astronomers, physicians, historians, architects, and other scholars who lived in the wake of the rise of Islam (7th-late 13th). There are countless thousands of them. And yet such names and their works cannot be just the fruit of the fantasy of such writers as Sarton[4609] or Suter.[4610] And this is only a minute portion of such Islamic science as has been uncovered.[4611] It is, conversely, almost impossible to name one single scientist in today's 'modern,' secular, Muslim societies.

But if Islam promoted science, and did not kill Islamic civilisation, as is abundantly argued here, what did? This is for the following chapter to answer.

-W.M. Watt: *The Influence*; op cit;
-S.E. Zaimeche: *The Hidden Debt to Islamic Civilisation* (Bayt al-Hikma; Manchester; 2005).
[4608] J. Owen: *The Skeptics of the Italian Renaissance* (Swan Sonnenschein &Co; London; 1908), p. 64.
[4609] G. Sarton: *Introduction;* op cit.
[4610] H. Suter: *Die mathematiker,* op cit
[4611] E. Savage-Smith: 'Gleaning from an Arabist's workshop: Current trends in the study of medieval Islamic Science and Medicine,' *ISIS,* 79 (1988): pp. 246-72.

Three

THE REAL CAUSES OF MUSLIM DECLINE

The major breaking point of Islamic civilisation and power occurred in the 13th century. It was then that Islam lost its major centres of power and civilisation, either permanently, such as in Spain, or permanently devastated by invaders, such as Baghdad, Merw, Bukhara, Aleppo, etc. This breaking point was itself preceded by other destructive events, which led up to it. The 13th century collapse was succeeded by other destructive events, which literally exhausted the Islamic realm. The Muslims came out with solutions to stem their decline, finding answers to one crisis just to be overwhelmed by another soon after, until in the end, the once most powerful civilisation and economic unit on the earth, became undermined thoroughly, with no longer the power or capacity to answer, and collapsed completely. It was only the Ottoman might that stopped Western occupation of the Islamic land centuries before it happened. When the Ottomans went into decline, the Muslim land was too weak to answer the subsequent Western occupation of its lands (18th-20th). When the occupiers left in the 20th century, they bequeathed the land of Islam of today: messy, backward, and in most places in the hands of thieving, corrupt, murderous despots and their elites.

It is how the land of Islam descended into decline from its apogee in the middle ages down to the colonial age that is outlined in this chapter. The crimes and the legacy of Western colonisation, and the messy state of today, are for others to deal with.

1.Internal Factors of Muslim Decline:

Al Biruni (d 1048) observes:

> 'When the Abbasids had decorated their assistants, friends and enemies indiscriminately, with vain titles, compounded with the word *daula* (that is empire, such as Helper of the empire, sword of the empire, etc..) the empire perished; for in this they went beyond all reasonable limits. This went on for as long that those who were especially attached to their court claimed something like a distinction between themselves and the others. Thereupon the caliph s bestowed double titles. But then also the others wanted the same titles and knew how to carry their point by bribery. Now it became necessary a second time to create a distinction between this class and those who were directly attached to their court, so the caliphs bestowed triple titles, adding besides the title of Shahinshah. In this way the matter became utterly opposed to common sense, and clumsy to the highest degree, so that he who mentions them gets tired before he has scarcely commenced, he who writes them loses his time writing and he who addresses them runs the risk of missing the time for prayer.'[4612]

Exquisite lines echoed by Von Grunebaum, who observes that the accession of the Abbasids, made possible largely through the support of Persians, brought to the fore the concept of kingship to which the Iranians had been accustomed from their native rulers.[4613] The Abbasid ruler as Von Grunebaum puts it:

> 'Consecrated by divine designation for his office, legitimised by his descent from a long line of kings, guarded by an elaborate etiquette devised to guard his person from defiling contact with the lowly crowd and to overawe the slaves over whom he had been set by the Lord of the Worlds- this type of despot now merged successfully with the theocratic representative of God.'[4614]

Wiet et al also note that gradually, 'life did its work,' and the Muslim masters adopted the ostentatious way of life of the Byzantines and the Iranians. It was from them that the caliphate courts, in Damascus and then

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[4612] Al-Biruni: *Chronology of Ancient Nations*, tr. E. Sachau (London, 1879), p. 129.
[4613] G E. Von Grunebaum: *Medieval Islam*, op cit; p. 155.
[4614] Ibid.

Baghdad, derived their predilection for luxury of dress, for gold plate, for sumptuous feasts, and for royal pomp.[4615]
Sarton, too, observes, that:

> 'Although the Persians had introduced into the Caliphate a greater love of beauty, urbanity, intellectual curiosity, and much fondness for discussion, all favourable for the progress of science, free thought was often followed by libertinage and immorality. No wonder that the genuine Arabs looked down upon the Persian intruders even as the old Romans looked down upon the Greeks. The fact is that every civilisation acts as a poison upon those who have not been properly inoculated; it would act that way even were it perfectly pure and did not contain (as it always does) evil elements. The Arabic strength and virtue were gradually undermined by Persian urbanity.'[4616]

That the Persians somehow undermined Arabic strength runs against the opinions of those, who in their overwhelming majority, go to the other extreme and grant the Persians nearly everything Islamic civilisation accomplished. In truth, the Persians are not responsible on their own for Muslim decadence. The Muslims became corrupt in urbanity, trivia, harems and the likes, not just where the Persians had an influence, but all over the place, including Muslim Spain, where direct Persian influence was very limited. Thus, in the words of Scott:

> 'The character of the Mussulmans of Spain was defiled by all the vices which follow in the train of prodigal luxury and boundless wealth. Among these drunkenness was one of the most common. Personages of the highest rank were not ashamed to appear in public while intoxicated… National degeneracy early indicated the approaching and inevitable dissolution of the empire. The posterity of the conquerors, who in three years had marched from Gibraltar to the centre of France, became in the course of a few generations cowardly, effeminate, corrupt.'[4617]

East and West, the Muslim realm produced its crop of such sort of rulers who accounted for the demise of Muslim power. Including amongst these Salah Eddin's (Saladin) own sons and brothers, who divided the realm he had bequeathed to them, spending their energies fighting each other and

[4615] G. Wiet et al: *History*: op cit; p.784
[4616] G. Sarton: *Introduction*; op cit: vol 1; at p.524.
[4617] S.P. Scott: *History*; op cit; Vol II, at pp 648 and 650.

capturing territory from each other rather than fighting the Crusaders.[4618] The Abbasid caliph, too, was weak, inept and corrupt. When Hulagu, the Mongol leader captured Baghdad in 1258, before massacring its one million inhabitants, he gave the order to count the number of women in the harem of Mustasim, the last Abbasid Caliph, a harem where 700 women and slave girls were found, and a thousand enuchs to serve them.[4619] The same with Al-Nasir, the Almohad ruler (r. 1199-1213), who was responsible for the loss of Muslim Spain, and whose harem contained nearly seven thousand females.[4620] Timur (d. 1405) represents the typical murderous savage ruler of Muslim birth: prone to betrayal, with mass murdering instincts, and frequently under alcoholic intoxication.[4621] The Safavids (16th century ff) (Persians it must be said, in their case), and Shah Ismail, in particular, likewise, shared the same qualities.[4622] And so did Boabdil of Spain who sold Grenada for gold in 1492.[4623] All these rulers, and others of similar ilk, behaved with levels of debauchery greater than that of any predecessor, anywhere.[4624] And to debauchery and corruption was shared amongst these rulers an insatiable urge for betrayal, unique in the annals of history. To their inept rule and other factors can be attributed the collapse of Islamic power and civilisation in both its halves, in the West and in the East.

a. In the West:

The unity and power of Muslim Spain was shattered at the death of its last great ruler, Al-Mansur (d. 1002). Before his death, he was gripped by a strong premonition:

[4618] C. Hillenbrand: *The Crusades*, op cit;.p.249.
[4619] Baron G. d'Ohsson: *Histoire des Mongols*; op cit; p.240.
[4620] S.P. Scott: *History;* op cit; vol 3; p. 643.
[4621] Depictions of his, which cane be gleaned from the reliable sources such as:
- Rodrigo de Zayas: *Les Morisques*; op cit; p. 136.
- E.R. Wolf: *Europe and the People Without History* (University of California Press; Berkeley; 1982), p. 45.
-Sir Edwin Pears: The Ottoman Turks to the fall of Constantinople. In *The Cambridge Medieval History* (Cambridge University Press, 1923), Vol IV: Edited by J. R. Tanner, C. W. Previte; Z.N. Brooke, 1923. , pp 653-705.
[4622] J.J. Saunders ed: *The Muslim World on the Eve of Europe's Expansion* (Prentice Hall Inc; New Jersey; 1966), pp 1 and 6.
[4623] J. Read: *The Moors in Spain and Portugal* (Faber and Faber, London, 1974), p.219.
[4624] See for more on these characters: S.P. Scott: *History*; op cit; S. Lane Poole: *The Moors*; op cit; P. Brummett: The Myth of Shah Ismail Safavi: Political Rhetoric and 'Divine' Kingship; in *Medieval Christian Perceptions of Islam*; ed by J.V. Tolan (Routledge; London; 1996), vol l; pp 331-59.

> 'May Allah grant that my prediction be not fulfilled; for my presentiments tell me the truth, the fire of civil discord will soon rage within the precincts of this palace and all the beauties of al-Zahira will before long be effaced-all traces of it will disappear from the face of the earth, this splendid mansion will be pulled down and converted into a heap of ruins, the gardens transformed into a dreary desert, treasures will be squandered and scattered.'[4625]

At Al-Mansur's death, in 1002, his son succeeded him and ruled for six years before the Peninsula entered a period of chaos. Civil war erupted throughout the territory. Cordoba was burned down in 1018, and frightened scholars sought refuge in the courts of Toledo, Granada, and Seville.[4626] Muslim Spain soon disintegrated into the era of the 'party kings' (*reyes de taifas, muluk at-tawa'if*) (1009 and 1091) into as many as thirty more or less independent rulers.[4627] Intrigues and armed conflict soon invited Northern Christian interventions.[4628] Not that the Spanish Christians were not themselves divided, but Muslim Spain surpassed them in fragmentation and anarchy.[4629] Christian strength was enhanced by papal edict, in 1063, Pope Alexander II promised the remission of their sins to any Christians taking part in a holy war against the Muslims of Spain.[4630] This brought French knights and adventurers streaming across the Pyrenees, and with these powerful reinforcements, Barbastro was taken in 1063 from the Muslims, followed by the massacre of its population and the mass rape of Muslim women.[4631] In 1085, the old Visigoth capital of Toledo fell to Alfonso VI of Castile,[4632] a victory achieved with the help of al-Mutamid of Seville.[4633] Al-Mu'tamid, himself, soon found himself suffering depredations at the hands of Alfonso's lieutenant, Garcia Jimenez, who had established himself in the middle of his kingdom with a garrison of 12,000 men at the stronghold of Aledo.[4634] Al-Mutamid took ship to North Africa and persuaded Yusuf ibn-Tashfin,

[4625] A. Thomson; M.A. Rahim: *Islam in al-Andalus* (Taha Publisher; London; 1996), p. 72.
[4626] W. Durant: *The Age of Faith*, op cit; chap 13; p.296.
[4627] For details on the rule of al-Mansur and the break up of the kingdom see J. Read: *The Moors*, op cit.
[4628] J.J. Saunders: *Aspects of the Crusades* (University of Canterbury, 1962), p.19.
[4629] B. Lewis: *Cultures in Conflict*; op cit; p. 19.
[4630] J. Read: *The Moors*; op cit; p.103.
[4631] For a succinct and vivid account on the early Christian conquest, and mass killings of Muslims in Spain and Portugal, see J. Read: *The Moors;* op cit.
[4632] J.J. Saunders: *Aspects of the Crusades;* op cit; p.19.
[4633] W. Durant: *The Age of Faith*, op cit; chap 19. p.460.
[4634] J. Read: *The Moors in Spain and Portugal*, op cit .p.133.

the leader of the Berber Almoravid to intervene.[4635] The Almoravids, who had just established their rule in Morocco agreed. In 1086, the Berber armies, manoeuvring en masse to the sound of drums, inflicted on the Christian knights a shattering defeat at Sagrajas near Bajadoz.[4636] Ibn Tashfin was prompted by local Muslim rulers to withdraw now the Christian danger had abated. Learning of Ibn Tashfin's withdrawal back to Africa, Alfonso resumed his offensive.[4637] Falling under renewed Christian threats the Muslim princes called again upon Ibn Tashfin, who twice more landed in the Peninsula, in 1088 and 1090; on the final occasion, deciding to take in charge the destinies of the country by himself, removing all princelings, and putting Muslim Spain under Almoravid control. A year after Ibn Tashfin had taken control in Spain, Sicily fell under total Norman control.

As in Spain, the fall of Sicily in 1091 was the result of Islamic dissentions. The beginning of the end of the Muslims on the Island took place early in the 11th century with open warfare between the Kalbid Emir of Palermo and the Zirid of Tunisia. Soon afterwards the Normans arrived to wrest the island from the Muslims. The initial Norman invasion of Sicily followed a local Muslim invitation.[4638] In 1056, Roger, the Norman leader, was contacted by the Emir of Syracuse who was in conflict with the Muslim ruler of Palermo. It was under these auspices the Normans crossed the straits and attacked Messina in 1060.[4639] The Normans who swept across South Italy in the next few decades were a small band but, thanks to special circumstances, were able to take hold of most of the territory.[4640] Roger landed in Sicily in 1061 and began to advance at the expense of the Muslims.[4641] This hardly seemed to bother the Muslims, as even when the Normans were half masters of the island, the Muslim chiefs continued to fight one another.[4642] In fact, the Sicilian Christians were less supportive of the Norman invasion than the Muslim factions.[4643] Had the Muslims not been divided, the Normans would have found no foothold; as it was, in the course of a generation, the small band of

[4635] Ibid.
[4636] G. Wiet et al: *History*; op cit; p.269.
[4637] J Read: *The Moors in Spain and Portugal;* op cit; p.128.
[4638] N. Daniel: *The Arabs;* op cit; p.144.
[4639] J. D. Breckenridge: The Two Sicilies; in *Islam and the Medieval West*; S. Ferber Editor; A Loan Exhibition at the University Art Gallery (State University of New York; April 6 - May 4, 1975), pp. 39-59; at. pp 46-7.
[4640] Ibid.
[4641] J. Glubb: *A Short History*; op cit; p.148.
[4642] G. Le Bon: *La Civilisation des Arabes*, op cit; p.230.
[4643] J. D. Breckenridge: The Two Sicilies; op cit; pp 46-7.

adventurers created a kingdom for themselves.[4644] The final Norman assault on Palermo began and, in January 1072 it surrendered to them.[4645] Less than twenty years later, the Normans finished any Muslim resistance and controlled the whole island.[4646]

North Africa, equally, was to fall to the same enmity amongst Muslims. North Africa experienced its most glorious page in history under the Aghlabids of al-Qayrawan (9th century).[4647] In respect to each and every accomplishment, whether in sciences, architecture, of works of public utilities, no dynasty compares to the Aghlabids.[4648] Aghlabid power and north African might were destroyed by the Fatimids in the early 10th century. Then, in 1057, the Fatimid Caliph, al-Mustansir sent the Banu Hillal and Banu Sulayman onto North Africa in a revenge mission against his ex-allies, the Zirid of Tunisia. In the wake of this onslaught, the coast of Tunisia and Tripolitania were utterly devastated.[4649] The invaders mercilessly ravaged all the open country of the once prosperous region north of the Atlas range, destroying villages, canals, dams, orchards and plantations, and turning cultivated farmland into pasture for their sheep and goats.[4650] The great metropolis of Al-Qayrawan was sacked by them in 1057. The Zirids clung to the towns on the coast, but the hinterland was ruined, and 300 years later, the Tunisian historian Ibn Khaldun could assert that his native land never recovered from the effects of this devastation.[4651] Such was the destruction, famines followed and so did Tunisian dependence on Norman Sicilian wheat. Soon afterwards, much of the realm began falling under the military grip of these same Normans.[4652] The Normans took Tunis, together with Djerba, Sfax,

[4644] N. Daniel: *The Arabs*; op cit; p.145.
[4645] J. D. Breckenridge: The Two Sicilies; op cit; 46.7.
[4646] N. Daniel: *The Arabs*; op cit; p.145.
[4647] G. Iver: Kairawan; *Encyclopaedia of Islam*; first series vol 4; pp. 646-9.
-H. Saladin: *Tunis et Kairouan;* op cit.
[4648] M al-Rammah: The Ancient Library of Kairaouan and its methods of conservation, in *The Conservation and Preservation of Islamic Manuscripts,* Proceedings of the Third Conference of Al-Furqan Islamic Heritage Foundation (1995) pp 29-47.
-Ibn al-Athir: *Al-Kamil fi'l Tarikh*; op cit.
-G. Iver: Kairawan; op cit; pp. 646-9.
-H. Saladin: *Tunis et Kairouan; op cit.*
[4649] D. Abulafia: The Norman Kingdom of Africa and the Norman Expeditions to Majorca and the Muslim Mediterranean; in D. Abulafia: *Italy, Sicily and the Mediterranean 1100-1400;* Variorum Reprints (London; 1987), pp. 27-49. p. 27.
[4650] J. J. Saunders: *A History of Medieval Islam* (Routledge; London; 1965), p. 155.
[4651] Ibid.
[4652] D. Abulafia: The Norman Kingdom; op cit; p. 27.

Mehdia, Monastir and Sousse.[4653] They threatened not just Tunisia but also the whole of North Africa. However, the timely intervention by the Almohads from the mid 12th century onwards, who fought and defeated the Normans, upset Norman-Papal plans seeking to extinguish Islam in North Africa as was eventually to happen in both Spain and Sicily.[4654]

b. In the East:

Just as in Spain, Sicily, and North Africa, Muslim strife invited their downfall in the East. The main factor: the Fatimids. Fatimid power (909-1171), Breckenbridge notes, did not just cause a major shift in the distribution of power in the 11th century, it sowed the seeds of changes within the land of Islam itself.[4655] Nearly two centuries before, when the Aghlabids of Tunisia took Sicily (827) the Muslim world was remarkably unified-'a chain of watchtowers along the North African coast could flash news from Alexandria to Gibraltar in a single day;' this situation changed with the rise of the Fatimids.[4656] In 910 they expelled the Aghlabid conquerors of Sicily from Tunis. Then, under their General Gawhar, a Sicilian Christian in origin, the Fatimids conquered Egypt; and in 969 moved their capital to Cairo.[4657] A year later, they established control in Damascus, thus splitting the Muslim world thoroughly. The Fatimid Caliph al-Hakim (r. 996-1021) went half mad with wealth and power, so much so as to proclaim himself God; sending missionaries to establish his cult among the people.[4658] His emissaries were killed by the Egyptian population before he himself was assassinated at the age of thirty six.[4659] Another Fatimid ruler, Mustansir (r. 1036-94) built for himself a pleasure pavilion, and lived a life of music, wine, and ease; which he said 'is more pleasant than staring at the Black Stone, listening to the Muezzin's drone, and drinking impure water' (from Makkah's holy well of Zamzam).[4660]

[4653] Ibn al-Athir: *Al-Kamil fi'l Tarikh;* op cit; see relevant sections.
D. Abulafia: *The Norman Kingdom;* pp. 32 ff.
[4654] See, for instance:
-R. Le Tourneau: *The Almohad Movement in North Africa in the Twelfth and Thirteenth Centuries* (Princeton; 1962).
-H.C. Lea: *The Moriscos of Spain* (Burt Franklin; New York; 1968) reprint.
[4655] J. D. Breckenridge: The Two Sicilies; op cit. p.45.
[4656] Ibid.
[4657] Ibid.
[4658] W. Durant: *The Age of Faith*, op cit; chap 13;p.285.
[4659] Ibid.
[4660] P.K. Hitti: *History*; op cit; p. 626; in W. Durant: *The Age of Faith*, op cit; p.285.

Thus, as the crusaders were approaching the Holy Land in 1096, Hillenbrand rightly notes, it was they who possessed the ideological edge over the Muslims.[4661]

The crusader onslaught was soon to be helped by a decisive factor: the eruption of the Assassin movement, a break away Ismaili group formed in Iran. In 1090, Hassan i-Sabbah, their leader, seized the fortress of Alamut in the Elburz mountains of northern Persia.[4662] From those fortresses, and during the two centuries of the crusades (1095-1291) the Assassins launched a campaign of organised and systematic murder of Islamic leadership unparalleled in history.[4663] In the space of less than two years, beginning in 1092, there was a clean sweep of all the major political leaders of the Islamic world from Egypt eastwards.[4664] In 1092 the greatest figure of Seljuk history, Nizam al-Mulk, de facto ruler of the Seljuk empire for over thirty years, was murdered by the Assassins. A month after Nizam, Malik Shah, the third Seljuk sultan, died in suspicious circumstances, after a successful twenty year reign, followed closely by his wife, grandson and other powerful political figures.[4665] Leaderless, the Islamic world was ridden with further internal strife and jockeying for power in both the Eastern Islamic world and Egypt. The two sons of Malik Shah, Barkyaruk and Mohammed were locked in a conflict, which gobbled up all the available military resources throughout the East.[4666] 11th century Syria, Lamonte notes, was 'a crazy quilt of semi independent states,' resulting from previous divisions of it made by the Byzantine Empire and the Fatimid Caliphate of Cairo.[4667] The Islamic world was thus in no position to fend off the attacks from Western Europe which were about to occur.[4668] The timing of the crusades, Hillenbrand notes, simply could not have been 'more propitious. 'Had the Europeans somehow been briefed that this was the perfect moment to pounce?... seldom had the arm of coincidence been longer.'[4669]
In launching the crusades in the East, in 1095, Pope Urban II, however, used the pretext of Muslim aggression:

[4661] C. Hillenbrand: *The Crusades,* op cit; p.103.
[4662] J.J. Saunders: *Aspects of the Crusades*; op cit. p.25.
[4663] Ibid.
[4664] C. Hillenbrand: *The Crusades,* op cit; p.18.
[4665] Ibid; p.33.
[4666] Ibid; p.38.
[4667] J.H. Lamonte: Crusade and Jihad: in *The Arab Heritage*, N.A. Faris editor (Princeton University Press, 1944), pp 159-198; p.163.
[4668] C. Hillenbrand: *The Crusades*, op cit;.p.18.
[4669] Ibid;.p.33.

> 'It is urgent for you to bring hastily to your brothers in the Orient the help so often promised and that's of pressing necessity. The Turks and the Arabs have attacked them...., and penetrating always further inside Christian countries, have on seven occasions beaten them in battle, and have killed and taken captive a great number, and have destroyed churches and devastated the kingdom.'[4670]

The pope, just like the Church hierarchy, was fully aware this was the best time to finish a Muslim world gripped by divisions and in chaos.

2.Invasions and Devastations:

The chaos within the Islamic lands acted as a major spur for the invaders who launched simultaneous attacks in the East and in the West. These invasions had devastating consequences on the Islamic realm. The destructiveness of such invasions is, however, generally minimised, and even ignored by Western historians who, as seen above, put the blame on Muslims for their own woes, instead. This is what is looked at in the following.

a. The Crusades (1095-1291):

The crusades caused widespread slaughter and destruction in the land of Islam. The massacre of Muslims was systematic, widespread, and represents one of the least known, but worst genocides in history. One instance amongst many was the taking in 1098 by the crusaders of Ma'arrat an'Numan in Palestine. The siege was valiantly sustained, until one night, some defenders began to desert their places, followed by others who saw them.[4671] The crusaders seized their chance, and scaled the undefended walls; then entered the city. The terrified population hid in their homes, but to no avail. For three days the slaughter never stopped;

[4670] Discours of Pope Urban II. It is re-transcribed by Fulcher of Chartres in Regine Pernoud: *Les Hommes et la Croisade* (Jules Tallandier, Paris, 1982).
[4671] Ibn al-Athir in F. Gabrieli: *Arab Historians of the Crusades* (London; Routledge; 1957), p.9.

the crusaders killed more than 100,000 people.[4672] The chronicler of nearby Aleppo, Ibn al-Adim (d. 1262), describes the carnage:

> 'They (the Franks) killed a great number under torture. They extorted people's treasures. They prevented people from (getting) water, and sold it to them. Most of the people died of thirst... No treasure remained there that was not extorted by them. They destroyed the walls of the town, burned its mosques and houses and broke the minbars.'[4673]

Christian sources, too, give the same account. Thus, Robert the Monk, following the taking of Ma'arrat:

> 'Our men walked through the roads, places, on the roofs, and feasted on the slaughter just like a lioness who had her cubs taken from her. They cut into pieces, and put to death children, the young, and the old crumbling under the weight of the years. They did that in groups… Our men grabbed everybody who fell in their hands. They cut bellies open, and took out gold coins. Oh detestable cupidity of gold! Streams of blood ran on the roads of the city; and everywhere lay corpses. Oh blinded nations and destined to death; none of that multitude accepted the Christian faith. At last Bohemond brought out all those he had first invited to lock themselves in the tower of the place. He ordered that all old women be put to death, and also old men, whose age had rendered useless; then all the rest he ordered to be taken to Antioch to be sold as slaves. This massacre of the Turks took place on 12 December; on Sunday; but on this day not all work could be accomplished; so the following day our men killed all the rest.'[4674]

Radulph of Caen said how:

> 'In Maarra our troops boiled pagan adults in cooking pots; they impaled children on spits and devoured them grilled.'[4675]

To avoid such a fate, many Muslims were said by a Christian writer to have jumped down wells to their deaths.[4676]

[4672] Ibid.
[4673] Y. Tabba: Monuments with a message, Propagation of Jihad under Nur al-Din (1146-1174) in *The Meeting of Two Worlds*; Ed V.P. Goss (Kalamazoo; 1986), pp. 223-40; at p. 233.
[4674] Robert the Monk, in G. Le Bon: *La Civilisation*, op cit; p. 248.
[4675] In Janet Abu Lughod: *Before European Hegemony;* op cit; p. 107.
[4676] R. Finucane: *Soldiers of the Faith* (J.M. Dent and Sons Ltd; London, 1983), p.106.

This fate was generalised to every single town and city taken by the crusaders: Antioch, Tripoli, Acre, etc, and of course Jerusalem. There, as Draper narrates:

> 'The capture of Jerusalem, as might be expected under such circumstances, was attended by the perpetration of atrocities almost beyond belief. What a contrast to the conduct of the Arabs! When the Khalif Omar took Jerusalem, A.D. 637, he rode into the city by the side of the Patriarch Sophronius, conversing with him on its antiquities. At the hour of prayer, he declined to perform his devotions in the Church of the Resurrection, in which he chanced to be, but prayed on the steps of the Church of Constantine; 'for,' said he to the patriarch, 'had I done so, the Musselmen in a future age would have infringed the treaty, under colour of imitating my example.' But, in the capture by the Crusaders, the brains of young children were dashed out against the walls; infants were thrown over the battlements; every woman that could be seized was violated; men were roasted at fires; some were ripped open, to see if they had swallowed gold; the Jews were driven into their synagogue, and there burnt; a massacre of nearly 70,000 persons took place; and the pope's legate was seen 'partaking in the triumph.'[4677]

A contemporary, Abbot Raymond of Agiles of the French town of Du Puy, who was present, wrote with glee:

> 'When our men took the main defences, we saw then some astonishing things amongst the Saracens. Some were beheaded, and that's the least that could happen to them. Others were pierced through and so threw themselves from the heights of the walls; others after having suffered in length were thrown into the flames. We could see in the roads and in the places of Jerusalem bits and pieces of heads, hands, and feet. Everywhere we could only walk through cadavers. But all that was only little…'

The abbot's description moves onto the Mosque of Omar, where:

> 'There was so much blood in the old temple of Solomon that dead corpses swam in it. We could see hands floating and arms that went to glue themselves to bodies that were not theirs; we could not distinguish which arm belonged to which body. The men who were doing the killing could hardly bear the smoke from the corpses.'[4678]

[4677] J.W. Draper: *A History*; Vol II; op cit; pp 22-3.
[4678] Abbot Raymond of Agiles; in G. Le Bon: *La Civilisation*; op cit; p. 249.

The populations of Syria and Palestine were nearly wiped out. Syria, for instance, at the time of the Frankish invasion the country's population stood at 2.7 million inhabitants;[4679] two centuries on, despite a revival under the Mameluks, in 1343, it stood at only 1.2 millions,[4680] a catastrophic population drop, which, Saunders notes, was every bit the equivalent of the worst disasters in history.[4681]

Modern, 20th century Western historians, however, with hardly any exception, set aside the bloody side of the crusades, or even justify them. Jean Richard even goes as far as blaming the massacre of the whole Muslim and Jewish population of Jerusalem by the crusaders on the fact that the crusaders:

> 'Had been infuriated by the insults hurled at the procession they had made beneath the ramparts.'[4682]

Generally, modern historians have cleansed crusade history of outrages, and they use one isolated statement by the Muslim Spanish traveller, Ibn Jubayr, to present the crusades in a very idyllic, humane form, implying that they had no negative impact on Muslim society. On his way from Tibnin to Acre, in the year 1184, Ibn Jubayr had remarked that Muslims lived prosperously with the Franks and owned their houses and other possessions. The French historian, Grousset, for instance, turns this account into '*Le plus bel eloge de la colonisation Francaise*' (the greatest praise in favour of French colonisation).[4683] Jean Richard, who devotes only three quarters of a page of his work to the status of Muslims under crusader rule, devotes the major part of this brief outline to Ibn Jubayr's passage, stating:

> 'But by no means all Moslems were slaves. The great majority of them were peasants; villains who were at first uncooperative, reluctant to work the land and liable to make armed attacks against the Franks. In the end, however, agreement was reached.

[4679] J. Cox Russel: late Ancient and Medieval Population, *Transactions of the American Philosophical Society,* vol. 48/III, 1958. In Y. Courbage and P. Fargues: *Chretiens*; op cit; p. 35.
[4680] A.N Poliak: The Demographic Evolution of the Middle East: Population Trends Since 1348, *Palestine and the MiddleEeast*, vol X. no 5, 1938; in Y.Courbage-Fargues: *Chretiens*; op cit; p. 35.
[4681] A note from R.A. Rotz on J.J. Saunders: *A History of Medieval Islam*; op cit; at http://www.iun.edu/~historyn/Turkmong.htm
[4682] J. Richard: *The Latin Kingdom of Jerusalem;* tr by J. Shirley (North Holland Publishing Company; Amsterdam; 1979), Vol A; p.15.
[4683] R. Grousset: *Histoire des croisades et du royaume Franc de Jerusalem* (Paris, 1935), 2: 754.

> Relations were good. Ibn Jobeir, who in 1184 travelled through the region round Acre, which was wholly Moslem, declared that they had better situation than under Muslim rulers.... Except for a poll tax on non Christians, not unlike the Muslim kharadj, of one dinar and five qirat, about one bezant, and a tax on fruit trees, the Franks required nothing of their subjects beyond the usual farm rents, paid in kind.'[4684]

Other historians, such as Chaudhuri, follow on the same line, also writing that Ibn Jubayr:

> 'Commented that the Frankish landowners had a better reputation for treatment of their agricultural workforce than the Muslims.'[4685]

Chaudhuri and mainstream historians, either do not know their subject, or tell fallacies. Had they read Ibn Jubayr, they would have to be particularly dishonest to make such comments. Ibn Jubayr, as Kedar rightly notes, devotes some of his most emotional lines to a description of the captive Muslim men stumbling in shackles and doing hard labour like slaves, and the captive Muslim women plodding along with iron rings on their legs.[4686] Ibn Jubayr also describes the efforts at ransoming Muslim prisoners from the far away Maghrib.[4687] Muslims had, indeed, been enslaved during the crusader conquest and many were captured and enslaved again during subsequent rounds of Frankish-Muslim warfare.[4688] Any Muslim seeking to escape their fate by running away risked losing their legs when caught.[4689] Ibn Jubayr also says that hardly anything differentiates some of the Franks from pigs, some such as King Baldwin IV whom he sees as *al-khinzir* (the pig) and his mother as *al-khinzira* (the sow), epithets he must have picked from the Muslims he encountered in Frankish Galilee.[4690] It must also be remembered that Ibn Jubayr's account, used by historians to praise the crusades, besides being isolated, also dates from the later stages of the crusades (1180s), when the mass slaughter of Muslims had lessened in intensity. By then, the Franks were

[4684] J. Richard: *The Latin Kingdom*; op cit; p. 133.
[4685] K.N. Chaudhuri: The Containment of Islam and the Background to European Expansion, in *The Global Opportunity*; ed by F.F. Armesto; Variorum (Ashgate Publishing; London; 1995), pp. 299-313; at p. 304.
[4686] Ibn Jubayr: Travels; p. 322; in B. Z. Kedar: The Subjected Muslims of the Frankish Levant, in *Muslims Under Latin Rule, 1100-1300,* ed J.M. Powell (Princeton University Press, 1990), pp 135-74. at p.153.
[4687] In B. Z. Kedar: The Subjected Muslims; op cit; p.153.
[4688] Ibid.
[4689] Ibid; p.170.
[4690] Ibid; p.155.

large estate owners, and needed farm tenants to crop the lands, and also needed Muslim farmers for tax raising purposes.

On the subject of taxes, Goitein and Mayer have convincingly shown that, far from being a trifle, Christian taxation of Muslims was a heavy burden for the poorer population.[4691] In addition to the poll tax paid by all Muslims, Muslim peasants paid up to one-half of their crops, as well as other customary fees.[4692] (Under an Islamic system they paid only the equivalent of the fifth of their crops in taxes). Erbstosser insists that the majority of the native peasants lived in a state of feudal dependency, that whilst the tax they paid varied from a quarter to half of the yield of their crops, they also carried compulsory labour, and the provision of draft animals for the building of castles in particular.[4693] There was also a poll tax imposed on the Muslims, and in addition the Muslims had to pay a tithe tax, which was paid to the local Catholic church via the state.[4694]

The crusades dealt a great blow to the Islamic economy. Prior to the crusades, the countryside of the East was an image of prosperity, captured by the description of the traveller Nasir I Khusraw who visited Dyar al-Bakir in northern Syria in 1046. He saw durable prosperity in these regions; abundant crops well cared for; low prices of goods due to abundance, a rich profusion of grapes and honey; active exploitation of the forest, and the thriving markets of Ma'arat an'Numan, fed by the prosperous surrounding farm lands, where fruit orchards, and wheat fields grew.[4695] The sight of the coastal regions was even more grandiose: Tripoli and its surrounding were covered in cultivated fields, and an abundance of orchards and gardens, vast plantations of sugar; citrus trees, banana plants, date palms… all thriving.[4696]
The crusades, by their mass killings and destruction, altered considerably this picture. Mass slaughter of the population and the rigours of war decimated both labour force and market. Irrigation works, orchards, and local economies were also destroyed. The loss of lands to the crusaders was particularly harmful. Farmlands were transformed, by virtue of a right of conquest to European feudal system; hence the Muslims, including

[4691] S.D. Goitein: *A Mediterranean Society*, op cit; 2: 380-93; H.E. Mayer: Latins, Muslims and Greeks in the Latin Kingdom of Jerusalem, *History* 63 (1978), pp 181-2.
[4692] H.E. Mayer: Muslims, pp 177-80.
[4693] M. Erbstosser: *The Crusades;* op cit; p. 130.
[4694] Ibid.
[4695] P. Guichard: Mise en valleur du sol et production: de la Revolution agricole au difficultes du bas moyen age; in *Etats, Societes*; op cit; pp. 175-98, at pp.175-6.
[4696] Ibid.

former owners, now found themselves forced into serfdom.[4697] Even most of the Muslims who had converted to Christianity had been made into serfs or slaves, and Muslim slaves were added from time to time to the labour force.[4698] This contradicts what Richard tells us, that Christian colonists were essentially free peasants, many of whom moved into lands newly recovered from the Muslims so as to benefit from the magnificent harvests that could be reaped there after the soil had lain fallow for so long.[4699] We note here his word: recovery (hence not usurpation). Moreover, Muslim existence under Frankish rule (other than serfdom) was in captivity and slavery, with the dividing line between the two rather blurred.[4700]

The Muslim loss of towns and cities such as Antioch, Beirut, Jerusalem, Tyre, Tripoli, Acre, etc, was equally disastrous. In these conquered cities, all Muslim property and possessions of those who had left were confiscated, and the lot of those who stayed was no better.[4701] The loss of such cities also impacted gravely on Muslim trade. These places, with rare exception, were to remain in crusader hands for between one and two centuries (Acre was recaptured by the Muslims in 1291). The whole trading network linking up the two halves of the Islamic world, East and West, and with the Mediterranean was thus broken. Trade now passed under Crusader control, and above all under the control of Venice, Pisa, and Genoa, which had assisted the crusades with their fleets. In exchange for such assistance, they had obtained substantial concessions from the papacy and local Frankish leaders.[4702] The Venetians in the 13th century acquired eighty villages near Tyre, also claiming a third of that city and quarters in Haifa, Acre, Tripoli, and Ascalon.[4703] This stranglehold on the entire trade of the

[4697] See for instance: J. Prawer: *Histoire du Royaume Latin de Jerusalem*; 2 Vols (Paris; 1969-70); I; p. 506 ff; C. Cahen: Notes pour une histoire de l'Agriculture dans les pays Musulmans medievaux; *Journal of the Economic and Social History of the Orient*; xiv; 1971; pp. 63-8. Notes Croisades; 298 fwd; And F. Chalondon: *Histoire de la Domination Normande en Sicilie*; 2 vols (Paris; 1907); vol ii: p.500.
[4698] A. Watson: *Agricultural,* op cit; Note 20; p. 211.
[4699] J. Richard: *The Latin Kingdom,* op cit; p. 133-4.
[4700] In B. Z. Kedar: The Subjected Muslims; op cit; p.153.
[4701] A.M. Nanai: L'Image du croise dans les sources historiques Musulmanes: in *De Toulouse a Tripoli,* AMAM; Colloque held between 6 and 8 December, 1995 (University of Toulouse; 1997), pp: 11-39 p. 20.
[4702] Z. Oldenbourg: *The Crusades,* op cit; pp. 295-300.
[4703] *Regesta*: 31, 84, 102-5; 139; 197-8; 282; 434; 632; 639; in C.R. Conder: *The Latin Kingdom of Jerusalem* (The Committee of the Palestine Exploration Fund; London; 1897), p. 208.

Holy Land ruined the local trades, and foreign rivals impoverished in the process Muslim and Jewish traders.[4704]
Other Islamic trading strongholds not falling into crusader hands suffered, too. Damascus was besieged, Alexandria, Damietta, and other cities were devastated, and this caused immense damage to professions, skills, crafts and trades.[4705] Insecurity was also rife everywhere. Aleppo, for instance, was threatened by the crusaders' presence for decades until the rise of Imad Zangi (r. 1128-1146) and Nur Eddin Zangi (r. 1146-1174) managed to regain some sort of urbane activity.[4706] There was hardly any safety movement for Islamic traders or commodities in and around much of what is today Syria-Lebanon-Palestine and coastal parts of Egypt; the risks of crusader attacks on caravans was also too high.[4707]

On the learning front, the impact of the crusades was even more catastrophic, as is highlighted here by the crusader taking of the city of Tripoli, a city inhabited by the highly literate Banu Ammar.[4708] The Banu Ammar had provided great help and support to the crusaders, as when Raymond of Toulouse laid siege to the castle of Krak and passed by Tripoli.[4709] However, despite being supportive of the crusaders, the city attracted their envy, and was stormed. Despite the crusaders' promise of safe conduct to the city's ruler, as one contemporary chronicler describes:

> 'On 12th July 1109, the crusaders plundered all that was in it, took the men captive and enslaved the women and children. The quantities of merchandise and storehouses and the books of its college and in the libraries of private owners, exceed all computation.'[4710]

The library of the Banu Ammar, the greatest in Syria, according to Oldenbourg, for the quality as well as the quantity of the books which were kept there, was scattered and destroyed.[4711] A later Muslim chronicler of the Crusades, Ibn al-Furat (1334-1405), does refer to the event, and also states that the crusaders did grab a certain number of

[4704] Z. Oldenbourg: *The Crusades;* op cit; pp. 297-8.
[4705] See for instance:
-Sir Steven Runciman: *A History of the Crusades;* op cit.
-J.J. Saunders: *Aspects of the Crusades* (University of Canterbury Publishing; Canterbury; 1962.)
[4706] A.M. Edde: Alep; in *Grandes Villes Mediterraneenes;* op cit; pp 157-75; at p. 157.
[4707] The battle of Hattin of 1187 was triggered by one such attack.
[4708] L. Cochrane: *Adelard of Bath* (British Museum Press, 1994), p. 33.
[4709] S. Runciman: A History; op cit; vol 2; p. 403.
[4710] Ibn al-Qalanisi: *Continuation of the Chronicle Damascus; The Damascus Chronicle of the Crusades;* ed and tr in English H.A.R. Gibb, (London; 1932); p. 89.
[4711] Z. Oldenbourg: *The Crusades;* op cit; p. 474.

books they saved from the flames, which engulfed the library at the orders of a priest.[4712] Cochrane notes, that although some of the books might have fallen in the hands of the English scholar, Adelard of Bath, who was present at the scene, most were certainly destroyed.[4713] This was a repeated event throughout the entire crusades. Muslim scholars were hardly able to comprehend why books were systematically destroyed.[4714]
The crusades also emptied the place of Muslims of intellectual stature, none of whom stayed permanently under Frankish rule, whereas Muslim refugees and fugitives from the conquered regions-among them a son and a nephew of Ahmad b. Qudama, both born in Jammail-played a considerable role in the dissemination of the idea of anti-Frankish jihad.[4715]

Thus Jihad came to the fore, replacing intellectual pursuits, especially as other invaders, the Mongols, threatened the whole Islamic realm with extinction.

b. The Mongols (1219-1280):

> 'Surpassing in cruelty the most barbarous people, they murdered in cold blood, in the conquered countries, men, women and children; burned towns and villages, destroyed the harvests, transformed flourishing land into deserts, and yet they were animated neither by hate nor vengeance; they hardly knew the names of the people whom they exterminated.... Their government was the triumph of depravity; all that was noble and honourable was abased... The history of the Mongols, stamped with their barbarity, offers only hideous pictures.' (Baron d'Ohsson)[4716]

It is in the year 1219 that the first Mongol invasion of the Islamic land took place. These first invasions (1219-21) were led by Genghis (Chingis) Khan. The Mongol hordes descended on Eastern Islam, the lands of Khwarizm, and other locations; the most populous, the most beautiful, and

[4712] Ibn al-Furat, quoted in Y. Eche: Les Bibliotheques; op cit; pp. 120-1.
[4713] L. Cochrane: *Adelard of Bath;* op cit; chapter 4; p. 33.
[4714] C. Cahen: *Orient et Occident au temps des Croisades* (Aubier Montaigne, 1983), p.82.
[4715] B. Z. Kedar: The Subjected Muslims; op cit; p.173.
[4716] Baron G. d'Ohsson: Histoire des Mongols; in R.H. Major: *A History of Medicine*; op cit; p. 258.

the best cultivated parts, whose inhabitants excelled in character and urbanism, says Spuler,[4717] and they devastated them. In three years, 1219-1221, the Mongols caused more lives to be lost than in any similar conflict of such duration notes Saunders.[4718] Jenghiz proceeded with the methodical destruction of the Khwarzmian kingdom.[4719] An army under Jenghiz's son Jagtai, captured and sacked Otrar, whilst another under Jenghiz himself, burned Bukhara to the ground, raped thousands of women, and massacred 30,000 men.[4720] A historian of Bukhara, a man fortunate, indeed, to have escaped with his life when his city was devastated in 1220, wrote:

> 'They came, they uprooted, they burned, they slew, they despoiled, they departed.'[4721]

Samarkand capitulated in March 1220; the inhabitants were ordered to evacuate the city, which was more easily plundered in their absence.[4722] The Turkish garrison was put to the sword, the artisans in the number of 30,000 were deported to Mongolia, and a great deal of indiscriminate killing went on.[4723] The tenor of destruction of the city was such, that a century later Ibn Battuta described Samarkand (and Balkh) as still largely in ruins.[4724]

In February 1221, the Mongols totally annihilated Hamadan and its population.[4725] Through Khurasan, the Mongols ravaged every town on their march, placing captives in their van, giving them choice between fighting their fellow men in front or being cut down from behind.[4726]

Merw fell in February 1221 to the Mongol leader Tolui who butchered 700,000 inhabitants,[4727] only eighty craftsmen were spared. Browne, in fact, put the total slaughter there at 1,3 million lives.[4728] The city was burned to the ground; its libraries, the glory of Islam, were consumed in the conflagration.[4729]

[4717] B. Spuler: *History of the Mongols* (London, Routledge& Kegan Paul, 1972), p.31.
[4718] J.J. Saunders: *The History of the Mongol Conquests* (Routlege & Kegan Paul; London; 1971), p. 55-6.
[4719] Ibid; p. 59.
[4720] W. Durant: *The Age of Faith,* op cit; p.339.
[4721] In W. Blunt: *Splendours of Islam;* op cit; p. 50.
[4722] J.J. Saunders: *The History of the Mongol Conquests;* op cit; p. 57.
[4723] Ibid.
[4724] Ibn Battuta: *Travels in Asia and Africa;* tr and selected by H.A.R. Gibb (George Routledge and Sons Ltd; London, 1929).
[4725] J.J. Saunders: *The History of the Mongol Conquests;* op cit; p. 59.
[4726] W. Durant: *The Age of Faith*, op cit; p.339.
[4727] Ibn al-Athir; 1221 in J. J. Saunders: *The History*; op cit; p. 60.
[4728] E.G. Browne: *Literary History of Persia* (Cambridge University Press; 1929), 3 Vols; Vol 2; p. 439.
[4729] W. Durant: *The Age of Faith*, op cit; p.339.

When the city of Gurganj fell in April 1221, the Mongols broke the dams and flooded the town, enslaved the women and children, deported the artisans to the number, it is said of 100,000, and slew the rest.[4730] Gurganj was completely ruined; the dams were never repaired, and the Oxus, having been diverted from its normal course, flowed into the Caspian for 300 years.[4731]

In Nishapur, taken in 1221, every man, woman, and child was killed except 400 artisans and artists who were sent to Mongolia; and the heads of the slain were pilled up in a ghastly pyramid.[4732]

In November 1221, Herat was levelled to the ground, after a full week had been devoted to killing the inhabitants. About one and half million people were massacred, and neighbouring cities met with a similar fate.[4733] The stench of the dead hung over the stricken land.[4734]

Bulliet and Petrushevskii cite figures of Mongol massacres amounting to 747,000 at Nishapur; 1.3 million at Merw; and 1.6 million at Herat.[4735] On the dreadful depopulation of eastern Persia, Juwaini says:

> 'Even through there be generation and increase until the Resurrection, the population will not attain a tenth part of what it was before.'[4736]

After a thirty or so year lapse, another Mongol invasion took place, this time aimed at the destruction of the very centre of the caliphate, Baghdad. This second invasion was the outcome of an alliance between the crusaders and the Mongols. It was made possible by the fact that not only did both sides share hatred of Islam, but most importantly by the fact that Nestorian Christianity held a great place alongside Shamanism amongst Mongol beliefs.[4737] Hulagu, the Mongol leader who was to take Baghdad in 1258, and his general Kitbuka had affinities with Nestorian

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[4730] J.J. Saunders: *The History of the Mongol Conquests;* op cit; p. 60.
[4731] On the changing course of the Oxus, consult G. Le Strange: *The Lands of the Eastern Caliphate* (Cambridge University Press; 1930), pp. 455-8.
[4732] W. Durant: *The Age of Faith*, op cit; p.339.
[4733] M. Levey; N. Al-Khaledy: Chemistry in the Medical Formulary of al-Samarqandi; *Chymia*; vol 11; pp. 37-44. p.37.
[4734] J.J. Saunders: *The History of the Mongol Conquests;* op cit; p. 61.
[4735] R.W. Bulliet: *The Patricians of Nishapur; A study of Islamic Medieval Social History* (Cambridge; mass; 1972), pp. 9-10; I.P. Petrushvskii: The Socio economic Conditions of Iran under the Il-Khans; In *Cambridge History of Iran*; v (Cambridge; 1968), pp. 483-537; p. 485.
[4736] Boyle's translation; I, 97; in J.J. Saunders: *The History of the Mongol Conquests*; op cit; Note 42; p. 215.
[4737] B. Spuler: *History of the Mongols* (London, Routledge& Kegan Paul, 1972), p.2.

Christianity.[4738] It was Hulagu's protection of the Nestorians, and the respect with which he welcomed and promoted the Katholikos Nestorian of Baghdad, which was to play a major role in the alliance between Mongols and Crusaders.[4739] Hulagu's wife, Doqouz Khatoun, was also Christian, and she ferociously loathed Islam.[4740] In fact the wives of Mangu, Kubilai and Hulagu, all of them Christians, played the leading part in the favours shown by the Mongols to the Christians.[4741] And the Popes in Rome, aware of this, in order to achieve their desired aims, worked very hard to stimulate the zeal of these Christian wives.[4742] There were also Christian soldiers employed as archers, or sailors... and adventurers all in the Mongol court.[4743]

In order to cement the Christian alliance with the Mongols, a strong number of Christian envoys were sent to the Mongols by St Louis, King of France, and the Popes.[4744] In 1245, Pope Innocent IV commissioned Giovanni de Carpini to explore the alliance with the Mongols against Islam.[4745] Equally, in 1253, St Louis sent the Franciscan William of Rubrouck to the Mongols.[4746] Rubrouck was then sent to meet the great leader himself, Mangu (Mongke) Khan further to the east.[4747] The Mongols acknowledged the Christian offers for an anti Muslim alliance, and sent back their replies. In 1249, in Cyprus, there came Mongol envoys to the French king, St Louis, offering alliance against the Muslims.[4748]

This alliance resulted in a promise by Mongke, the Mongol general, brother of Hulagu, to the King of Armenia to conquer the Holy Land and give it straight back to the Christians.[4749] For the Christians, however, it was not just Jerusalem that was the aim, but to turn the Mongols 'into a major asset for the West,'[4750] and 'to deal the mortal blow to the Muslims

[4738] B Spuler: *Les Mongols dans l'Histoire* (Payot, Paris, 1961).
[4739] A. Mieli: *La Science Arabe et son Role*; op cit; p.147.
[4740] Ibid.
[4741] Hayton, Saint Martin Brosset quoted in W. Heyd: *Histoire du Commerce*. op cit; Vol II; p. 66.
[4742] Jean Richard: *La Papaute et les Missions d'Orient au Moyen Age* (Ecole Francaise de Rome; Palais Farnese; 1977), p. 104.
[4743] Ibid.
[4744] Innocent IV: *Statuta capitulorum generalium ordinis Cisterciensis*, ed. J. Canivez, Vol II, Louvain, 1934, ad. ann.1245, & 28, p. 294. in J. Richard: *La Papaute et les Missions d'Orient*; op cit; p.66.
[4745] G. Sarton: Introduction; Vol II; op cit; p.37.
[4746] *William of Rubrouck, envoye de Saint Louis, Voyage dans l'empire Mongol (1253-1255)* (Payot, Paris, 1985).
[4747] C.R. Conder: *The Latin Kingdom of Jerusalem;* op cit; p. 372.
[4748] Ibid; p. 350.
[4749] Hayton; in W. Heyd: *Histoire*; Vol II; op cit; p. 68.
[4750] R.W. Southern: *Western Views of Islam in the Middle Ages*, op cit; p.44:

and thus guarantee the rule of the cross over the Holy Land.'[4751] For the Christian West the Mongol invasions were, indeed, aimed at 'the final and long awaited fall of Islam.'[4752] Maybe reaching even further, such invasions were a response to a dream 'of a world from which the Arabs had been eradicated.'[4753]

Western authorities, religious, or scholarly, remain on the whole, silent about this alliance, seeking to detach the Christian role from the Mongol atrocities committed against the Muslims.[4754] What is definitely known is that, three years after the return of the Pope's envoy, Rubrouck, to the Mongols, Hulagu crossed Persia and devastated Baghdad.[4755]

Early in 1258, the Mongols reached Baghdad. On 30th January, 1258, Hulagu opened a massive bombardments with his mangonels against the capital. Within three days, the defences of Baghdad were in ruins. On 5th February, the Mongols climbed a long stretch of the walls.[4756] For a week the Mongol army waited on the walls, no soldier entering the city.[4757] On their arrival, the Mongols, understandably, favoured Christianity,[4758] which prompted the Caliph to choose a Nestorian, Patriarch Machida II, to negotiate the surrender of Baghdad. Hulagu, thereupon, ordered the Caliph's army to assemble on the plain outside the walls, where all were massacred.[4759] Then came the turn of the population. Christian quarters were spared,[4760] but the whole Muslim population was entirely exterminated.[4761] 800,000 of the inhabitants were brought out in batches from the city to be massacred, and the greater part of the city itself was destroyed by fire.[4762] This is a brief narration of the event:

> 'The horrors of rapine, slaughter, and outraged humanity lasted for six weeks. The palaces, mosques, and mausoleums were

[4751] Jean Richard, 'l'Extreme Orient legendaire au Moyen Age: Roi David et Pretre Jean,' in *Annales d'Ethiopie*, Vol II (Paris, 1957), pp 225-42.
[4752] M. Rodinson: *Europe and the Mystique of Islam*; op cit p.27.
[4753] N. Daniel: *The Arabs;* op cit; p.218,
[4754] Whether Saunders who has been referred to here, or other historians such as Richard, who dealt with the issue, and even those seemingly favourable to the Muslims, such as Daniel (*The Arabs and Medieval Europe)* all deny that the alliance between the Christians and Mongols to exterminate the Muslims worked on the ground, whilst it did.
[4755] C.R. Conder: *The Latin Kingdom;* op cit; p. 381.
[4756] J. Glubb: *A Short History;* op cit; p.207.
[4757] Ibid.
[4758] Y. Courbage, P. Fargues: *Chretiens*; op cit; p. 29.
[4759] J. Glubb: *A Short History;* op cit; p.207.
[4760] Y. Courbage, P. Fargues: *Chretiens*; op cit; p. 29
[4761] 800, 000 people according to H.H. Howorth: *History of the Mongols* (London, 1927) in Y. Courbage and Fargues: *Chretiens*; op cit; p. 29.
[4762] Sir Thomas W. Arnold: Muslim Civilisation; op cit; p.279.

destroyed by fire or levelled to the earth for their golden domes. The patients in hospitals and the students and professors in the colleges were put to the sword. In the mausoleums the mortal remains of the sheikhs and pious imams, and in the academies, the immortal works of great and learned men, were consumed to ashes; books were thrown into the fire, or where that was distant and the Tigris near, were hurried in the waters of the latter. The accumulated treasures of five centuries were thus lost for ever to humanity. The flower of the nation was, thus, completely destroyed.'[4763]

'For five hundred years,' [says Glubb,] 'Baghdad had been a city of palaces, mosques, libraries and colleges. Its universities and hospitals were the most up to date in the world. Nothing now remained but heaps of rubble and a stench of decaying human flesh.'[4764]

For Browne:

'An awful catastrophe was inflicted on Islam, a blow from which it has never recovered.'[4765] 'Never probably, was so great and splendid a civilisation so swiftly consumed with fire and quenched with blood.'[4766]

Following the taking of Baghdad, the Mongols advanced into Syria; in the region of Mayafaraqin, where the great part of the Muslim population was massacred.[4767] On 18 January 1260, the Mongols established their camp before the city of Aleppo, and after a siege of a week, they burst into the city through the Bab al-Iraq.[4768] They slaughtered and pillaged for six days, until the streets were filled with the slain.[4769] It is estimated that one hundred thousand young women and children were taken as slaves, the remainder of the inhabitants having been systematically exterminated.[4770] Ruined and half deserted, Aleppo would not recover from the carnage for

[4763] E. Gibbon: The Decline and Fall, quoted in Syed Ameer Ali: *The Spirit of Islam;* op cit; p. 402.
[4764] J. Glubb: *A Short History*; op cit; p.207.
[4765] E.G. Browne: *Arabian Medicine* (Cambridge University Press, 1962), p. 91.
[4766] E.G. Browne in R.H. Major: *A History of Medicine;* op cit; p. 259.
[4767] W. Samolin: Mongol Empire; in *Dictionary of Middle Ages*; op cit; vol 8; pp. 470-6; p.472.
[4768] R.S. Humphreys: *From Saladin to the Mongols* (State University of New York Albany; 1977), p.349.
[4769] Ibid.
[4770] J. Glubb: *A Short History*; op cit; p. 207.

another century.[4771] The Mongol siege of Damascus began in January 1260, and after six days they breached the walls and broke into the city; the massacre of the citizens lasted for five days.[4772]

Only Egypt was left, and Hulagu was determined to make an end of her.[4773] A Mongol embassy was sent by Hulagu to Cairo, with a letter summoning the Mamluks to surrender.[4774] The Mamluk leadership met in council and decided instead on war.[4775] On the 3rd of September 1260, the Mamluks of Egypt crushed the Mongol army at Ain Jalut, and secured the survival of the Islamic land.[4776]

The Mongol onslaught was, however, to last for another few decades. In the years 1299-1300, the Mongols devastated more Syrian towns and cities. Virtually the whole of al-Salihiyya suburb to the north of Damascus was pillaged and burned. Many important buildings were destroyed and the population was plundered and murdered.[4777] Many hospitals and madrasas were lost. Inside the city, the area around the citadel was severely damaged, and important schools were burned. The outlying villages suffered, too.[4778]

The effects of the Mongol invasions can never be fully counted, but one major impact was the near total depopulation of the Muslim East. The province of Diyala, near Baghdad, indicates that this province had almost 900,000 inhabitants in the days of the Abbasids (c. 800), and only around 60,000 persons in 1300 under Mongol rule. This represents over a 90% drop in population, which put the province back to levels of roughly 1500 B.C.[4779] Further east, in the surrounding of Herat, in 1236, there were no peasants left to work the land,[4780] which led to further declines in numbers.[4781] The Herat *wilaya* (regional district) which counted 400

[4771] Ibn Wasil: *Mufarrij al-Kurub fi akhbar Bani Ayyub,* Ed G. Shayyal; S. Ashur; and H. Rabi; 4 Vols (Cairo; 1953); 147b; 149b; C. Cahen: *La Syrie du Nord a l'epoque des Croisades (*Paris; Geuthner; 1940), pp. 705-6.
[4772] W. Samolin: Mongol Empire; op cit; p.473.
[4773] C. Dawson: *The Mongol Mission* (Sheed and Ward; London; 1955); p. xxvi.
[4774] Baron G. d'Ohsson: *Histoire des Mongols*; op cit; Note 2; p. 332.
[4775] Ibid.
[4776] For plenty more on this, see: U. and M.C. Lyons: *Ayyubids, Mamluks and Crusaders, Selection From the Tarikh al-Duwal wal Muluk of Ibn al-Furat*; 2 vols (W. Heffer and Sons Ltd, Cambridge, 1971).
[4777] I. M. Lapidus: *Muslim Cities*; op cit. p. 13.
[4778] Ibid.
[4779] C. Issawi: The Decline of Middle Eastern Trade; in *The Global Opportunity*, ed by F.F. Armesto; op cit; pp 133-154; at p. 136.; and A note from R.A. Rotz on J.J. Saunders; op cit.
[4780] P. Guichard: Mise en valeur; op cit; p. 195.
[4781] Ibid.

villages in the 10th century, only counted 167 in the 15th century, a fall compounded by considerable impoverishment; a state of desolation, which the 14th century Moroccan traveller, Ibn Battuta, could still see a century after the Mongols had made their irruption into those parts.[4782]

Also resulting from the Mongol invasion, the Muslim Middle Trade Route, which began at the Mediterranean coast of Syria/Palestine, crossed the small desert and then the Mesopotamian plain to Baghdad, before diverging to follow either the land or sea alternatives, was also devastated by the pincer action of crusaders and Mongol armies.[4783] Weissmann explains that the lacuna of information about Baghdad between 1258 and the Ottoman conquest some 600 years later is, in itself, an important indicator of the reduced importance of the city.[4784] The fact that Islamic scholars no longer discussed the city and travellers seldom mentioned it suggests that the major trade routes no longer went through Baghdad.[4785] Weismann argues that Baghdad's decline was political, economic, demographic, and social, the economic decline so evident now, since long distance trade routes bypassed Baghdad.[4786]

Farming, too, was ravaged by the Mongols. The mass killings and destruction left extremely little, and the Mongols cared little for an activity, which under the Muslims had reached extremely high levels of sophistication. The ravaged irrigation works, for instance, did not recover for five centuries afterwards.[4787] Famines ensued. Baghdad, for an instance, suffered their frequent recurrences.[4788]

The most devastating impact of the Mongol invasion, however, was on Islamic culture and learning. Muslim civilisation in the East, Padover says, was finally crushed by the invading hordes of Mongols and Tatars, culminating in 1258, when Hulagu sacked Baghdad.[4789] Neither Genghis Khan, nor Hulagu, had any regard for human life or institutions of culture: they stabled their horses in mosques, burned libraries, used precious manuscripts for fuel; and razed conquered cities with their populations to the ground.[4790] Pacey observes how one notably perceptive historian of European industry compares the effects of the Mongol invasion to the

[4782] Ibid.
[4783] Janet L. Abu-Lughod: *Before European Hegemony*, op cit; p.145.
[4784] K. Weismann: Lecture at the University of Chicago; unpublished; 1986; in J. L. Abu Lughod: *Before the European;* p. 195.
[4785] Janet L. Abu Lughod: *Before European Hegemony*; op cit; p.195.
[4786] K. Weismann: Lecture; op cit.
[4787] C. Issawi: The Decline; op cit; at p. 136.
[4788] Janet L. Abu-Lughod: *Before European Hegemony*, op cit; p.196.
[4789] S.K. Padover: Muslim libraries; op cit; p. 355.
[4790] S.K. Padover: Muslim libraries; op cit; p. 355.

collapse of the Roman empire in the fifth century, a disaster which then had set European science back almost a thousand years; similarly, the Mongol invasions of the thirteenth century ended the classical Islamic civilisation and new Dark Ages followed.[4791] A very relevant observation, indeed, which finds no better echo than Durant's exceptional outline of the whole Mongol effect on Islamic civilisation, very much worth repeating in full, including a brief narration again of the taking of the capital of Islamic civilisation, Baghdad:

> 'On February 13, 1258, Hulagu and his troops entered Baghdad, and began forty days of pillage and massacre; 800,000 of the inhabitants, we are told, were killed. Thousands of scholars, scientists, and poets fell in the indiscriminate slaughter; libraries and treasures accumulated through centuries were in a week plundered or destroyed; hundreds of thousands of volumes were consumed. Finally the Caliph and his family, after being forced to reveal the hiding place of their secret wealth, were put to death. So ended the Abbasid caliphate in Asia. Hulagu now returned to Mongolia. His army remained behind, and under other generals it advanced to the conquest of Syria. At Ain Jalut, it met an Egyptian army under the Mamluk leaders Qutuz and Baybars, and was destroyed (1260). Everywhere in Islam and Europe men of all faiths rejoiced; the spell of fear was broken. In 1303 a decisive battle near Damascus ended the Mongol threat, and saved Syria for the Mamluks, perhaps Europe for Christianity.
>
> Never in history had a civilization suffered so suddenly so devastating a blow. The barbarian conquest of Rome had been spread over two centuries between each blow and the next some recovery was possible; and the German conquerors respected, some tried to preserve, the dying Empire which they helped to destroy. But the Mongols came and went within forty years; they came not to conquer and stay, but to kill, pillage, and carry their spoils to Mongolia. When their bloody tide ebbed it left behind it a fatally disrupted economy, canals broken or choked, schools and libraries in ashes, governments too divided, poor, and weak to govern, and a population cut in half and shattered in soul. Epicurean indulgence, physical and mental exhaustion, military incompetence and cowardice, religious sectarianism and obscurantism, political corruption and anarchy, all culminating in piecemeal collapse before external attack—this, and no change of

[4791] D.S. Landes: *The Unbound Prometheus*; 1969; pp. 29-30 in A. Pacey: *Technology*; op cit; p. 45.

> climate, turned Western Asia from world leadership to destitution, from a hundred teeming and cultured cities in Syria, Mesopotamia, Persia, the Caucasus, and Transoxiana into the poverty, disease, and stagnation of modern times.'[4792]

This devastating blow was simultaneous with another hitting Islam in its western portion.

c. Sicily and Spain (1085-1265):

Sicily:

It is worth recalling that the initial Norman invasion of Sicily followed a local Muslim invitation.[4793] Roger landed in Sicily in 1061 and began to advance at the expense of the Muslims.[4794] A Norman assault on Palermo began, and in January 1072 it surrendered to them.[4795] Less than twenty years later, the Normans finished any Muslim resistance and took control of Sicily.[4796]

There is abundant praise in the literature for the tolerance of Muslims under Norman rule,[4797] a tolerance which was only part of the picture, though. Muslims, it is true, were appreciated for their services, their culture, and the place of the geographer al-Idrisi in the Norman court is a good instance of this.[4798] Amidst instances of tolerance, appreciation, and favours, however, the inexorable truth prevailed, that Muslims, as a minority living amidst Christians, have had no place. 'When William of Apulia is describing the capture of Palermo in his *De Rebus Gestis Normannorum in Sicilia*, he speaks of Roger's offer of safety and favour to the Muslim inhabitants. At the same time he destroys all the mosques, and turns the principal mosque into a church of the Virgin, so that 'where demons had sat should now be the seat of God and a fitting doorway to

[4792] W. Durant: *The Age of Faith;* op cit; pp. 340-1.
[4793] N. Daniel: *The Arabs*; op cit; p.144.
[4794] J. Glubb: *A Short History*; op cit; p.148.
[4795] J. D. Breckenridge: The Two Sicilies; 46.7.
[4796] N. Daniel: *The Arabs*; op cit; p.145.
[4797] Such as in P.K.Hitti: *History of the Arabs*, op cit; p. 606.
[4798] C. Waern: *Medieval Sicily* (Duckworth and Co; London; 1910), pp. 47-8.

heaven.'[4799] 'This is not a bad summary of the mercy that Europe would always offer the Arabs: conditional on the destruction of their religion, and, ultimately of their separate identity,' says Daniel.[4800]
It was their religion, rather than their social status, that distinguished the Muslims, and it is known that when, for whatever reason, royal protection of them was powerless, they became liable to persecutions unleashed by the Latin newcomers who did not share the tolerant attitude of the government to these infidel subjects.[4801] It only required spates of tension, rumours, and isolated incidents for tolerance and favours to turn into widespread massacres. The fate of the Muslim population on the island would, indeed, be sealed by a series of massacres.[4802] Under the rule of William I (The Bad) (r. 1154-1166), Muslim merchants of Palermo were massacred in the marshes of Papiretum in 1160.[4803] Muslim courtiers and other elites were in turn massacred in March 1161, following a palace revolt. They were killed wherever they could be found, many in the streets, others in their warehouses, and countless more in their offices.[4804] In the same year, the Lombards invaded the royal domain and slaughtered the Muslims wherever they found them.[4805] Under their leader Roger Sclavus, they launched a series of Pogroms, forcing the Muslims to flee westward to safer areas, where the population was still predominantly Muslim.[4806] They destroyed Muslim communities, both those who lived among with Christians in different towns, and those, who, living apart, possessed their own villages, and with no distinction for sex or age.[4807] A few escaped, disguised in Christian dress to the temporary safety of Muslim towns in the south, but felt such a horror of the Lombard areas that for generations they would only unwillingly pass through them.[4808]
Under William II (r. 1166-1189), and then under Frederick. II (King of Sicily 1208-1250), the condition of Muslims improved somewhat. The latter, though, had to submit to pressure, and repeated papal edicts to

[4799] In N. Daniel: *The Arabs*; op cit; p. 148.
[4800] Ibid.
[4801] D. Matthew: *The Norman Kingdom of Sicily* (Cambridge University Press; 1992), p. 92.
[4802] B.Z. Kedar: Crusades; op cit; p. 52.
[4803] F. Falcand: *Liber de Regno Sicilae*, p. 52. in H. Bercher, A. Courteaux, J. Mouton: Une abbaye latine dans la societe Musulmane: Monreale au XIIem siecle. *ANNALES* Vol 34 (1979), pp. 525-47; p.538.
[4804] N. Daniel: *The Arabs*; op cit; p. 149.
[4805] Ibid; p. 151.
[4806] D. Abulafia: *Commerce and Conquest in the Mediterranean, 1100-1500* (Variorum, 1993), p. 108.
[4807] N. Daniel: *The Arabs;* op cit; p.151.
[4808] Ibid.

suppress the Muslim presence. He, first, deported the Muslim population to the Italian hinterland, to Lucera. Bitter and inflammatory Papal rhetoric, however, consistently pressed the Emperor to remove the Muslims.[4809] The Muslims in Pope Gregory's (pope 1227-1241) words:

> 'Placed almost in the middle of the kingdom, can more easily corrupt the Catholic faith by the venom of their infidelity. Thence greater dangers take hold, for Christians are mixed in with them. Through companionship with pagans the flocks of the faithful depart from the Lord's fold.'[4810]

The Muslim colony of Lucera survived for another generation. Then, following the defeat of Manfred, Frederick's son, at the hands of a Papal-French army, the fate of the Muslims was sealed.[4811] They were all sold as slaves, or slaughtered en masse. Little is known or said about this.[4812] The colony was officially disbanded by Charles II of Anjou in 1300.[4813] Hearing the news of the Muslim extinction, Pope Boniface VIII was overwhelmed with delight.[4814]

The final extinction of the Muslims in the early years of the 14th century came as the culmination of two centuries of depredation under Norman rule that had caused them to lose wealth, privileges, and culture.

The Muslims were first gradually economically impoverished. Whereas in the late 12th century the majority of Palermo's merchants were still Muslim, by the late 13th century they were mainly Latin, in large measure, immigrants or descendants of recent immigrants.[4815] Outside the court, the Muslims were driven increasingly from the public places and from the fertile valleys into the hills.[4816] During the reign of William II (1166-89), many Muslim cultivators took refuge in the mountains, whilst French and Lombard nobles gained control of most of their land.[4817] Gradually, in

[4809] J.P. Lomax: Frederick II, His Saracens, and the Papacy, in *Medieval Christian Perceptions of Islam,* Edited by J.V. Tolan; op cit; pp. 175-97. p. 179.
[4810] MGH (Monumenta Germaniae Historica) Epist. Saec. XIII 1:574-5; No 676 in J.P. Lomax: Frederick II, p. 185-6.
[4811] On the French-papal victory, and impact on Muslims, see Ibn Wasil from the Arabic manuscript; 1702; Caetani collection; pp. 121-3.
[4812] D. Abulafia: *Commerce and Conquest;* op cit; p. 4.
[4813] H. Bresc: *Un Monde Mediterraneen: Economies et Societe en Sicile*, 1300-1450: 2 vols (Rome-Palermo, 1986), vol 2: p.583.
[4814] Housley: The Italian crusades; p. 65. In J.P. Lomax: Frederick II; p. 189.
[4815] D. Abulafia: *Commerce and Conquest;* op cit; p. 105.
[4816] N. Daniel: *The Arabs;* op cit; p. 148.
[4817] Note 27, p. 184 in A.M. Watson: *Agricultural Innovation*; op cit.

fact, the Muslims became concentrated largely in mountainous regions.[4818] The agricultural skills that they had brought with them from Africa disappeared. On the Monreale estates around 1200 specialised forms of cultivation and crafts gave way to a more monotonous concentration on production of wheat, skills disappearing as the Muslim population declined in numbers.[4819] Muslims employed on the land lost more of their revenues to ever more strenuous taxes.[4820] Much worse, even, from being land owners, the Muslims were now given the choice to be sold into slavery or settled on the land as serfs.[4821] Documents exist showing Muslim labourers granted to some churches as at Agrigento and Mazara, one hundred Muslims in round numbers.[4822] When the church of Catania was originally founded as a monastery, Roger granted it all the Muslims who had once lived there, even those who had fled in fear of Norman occupation, and their children, wherever they had since settled in Sicily.[4823] The tenants of Montreale estate seem to have been bound to the soil; in a deed of 1177 three Muslims acknowledged themselves to be serfs of the Abbot Theobald.[4824] William II granted thirty Muslims to a monastery at Palermo.[4825] The record also shows that one estate at Aci, alone, claimed over five hundred men.[4826] Outside Palermo, squatting in all waste places in miserable hovels were the innumerable serfs, generally Muslims.[4827]

The Loss of Sicily was likewise a terrible blow to the wider Islamic economic system. Udovitch's outline of the island's economy prior to its fall to the Normans captures perfectly its role within the Islamic economic network.[4828] This period of Muslim rule in Sicily, Udovitch says, coincided with the early phases of the commercial revolution of the Middle Ages and was an era of brilliant economic prosperity for the Island. Sicily was at the very hub of the expanding commercial activity in

[4818] Ibid; Note 21; p.211.
[4819] On this process see the valuable article of H.Bercher, A. Courteaux, and J. Mouton: 'Une abbaye latine; op cit.
[4820] D. Matthew: *The Norman Kingdom of Sicily;* op cit; p. 87.
[4821] C. Waern: *Medieval Sicily*; op cit; p. 86.
[4822] D. Matthew: *The Norman Kingdom of Sicily;* op cit p. 89.
[4823] Ibid.
[4824] C. Waern: *Medieval Sicily*; op cit; p. 89.
[4825] D. Matthew: *The Norman Kingdom of Sicily;* op cit, p. 90.
[4826] Ibid; p. 89.
[4827] C. Waern: *Medieval Sicily*; op cit; p. 97.
[4828] A.L. Udovitch: Islamic Sicily; in *Dictionary of the Middle Ages*; Vol 11; pp. 261-3; p.262.

the Mediterranean world.[4829] From at least the late 10th century, Sicily was a major producer of both raw and woven silk, which was actively traded in Mediterranean commerce, whilst its gold coin, the *rubaiya*, or quarter dinar, was highly esteemed, much in demand in Egypt and in the trading towns of Syria and Palestine.[4830] More importantly, together with Tunisia, Sicily during this period was at the intersection of a number of major trade routes; caravans from Sijilmasa in southern Morocco, carrying African and Moroccan commodities, made their way to Tunisia, and from there these goods found their way to the markets of Palermo and Mazara.[4831] Sicily also served as a commercial intermediary between Muslim Spain and the Muslim East, and ships travelling between the two ends of the Mediterranean regularly called at its ports. For European (mostly Italian) merchants in search of Eastern goods (flax, sugar, textiles of Egyptian provenance, pepper, spices, medicinal herbs, and so forth), the markets of Palermo and Mazara (as well as those of the Tunisian coastal towns) were closer and more accessible than those of the eastern Mediterranean.[4832] Even after the middle of the 11th century, when Egypt replaced Sicily and Tunisia as the hub of East-West trade, Sicily remained an important centre of international commerce, and reports on the activity and price levels of its markets were a regular part of the commercial correspondence of the 11th century.[4833]

Once Sicily was lost, this crucial role in the Islamic economic system was lost, too. Much worse, as will be amply seen further on, as soon as Sicily fell into Norman hands, it became the principal centre from where were launched the most devastating attacks on the Muslim realm to the south (North Africa) and to the east (during the crusades). Many such attacks on Muslim North Africa were led by Muslim officers and Muslim sailors serving the Sicilian crown, and a considerable proportion of Frederick's Army which went on the crusades with him was also made up of Muslims.[4834]

The Loss of Sicily finally meant the loss of one jewel of Islamic culture and civilisation. In Muslim times, travelling to the island in the years 972-3, the geographer Ibn Hawqal described the quarters of Palermo, their palaces and above all their hundreds of mosques: 'The mosques of the city and of the quarters round it outside the walls exceed the number of three

[4829] Ibid.
[4830] Ibid.
[4831] Ibid.
[4832] Ibid.
[4833] Ibid.
[4834] D. Abulafia: *Commerce and Conquest*; op cit; p.112.

hundred.'[4835] He had never seen an equal number of mosques, even in cities twice as large; buildings, which as well as being places of worship, also served as schools each with its own schoolmaster.[4836] There was also the University of Balerm (Palermo), which though it scarcely rivalled that of Cordoba, nevertheless had its share of capable scholars, such as Ibn Hamdis, the noble Syracusan who left the court of Count Roger at Palermo for Muslim Spain, where he wrote and reminisced about his youth on the Island.[4837] The schools of Muslim Sicily, like those of Muslim Spain, had long been the resort of students, ambitious for literary attainments and distinction, from every country in Europe.[4838] The culture, arts and scholarship of Sicily was inherited by the Normans when they took over the island. Their adoption of aspects of Islamic culture was, however, put within a Christian mould, and gradually, as conditions worsened for Muslims, the independent Islamic culture was removed. Increasingly, the island became unattractive for devout Muslims as Latin settlers came in from other parts of Christendom, bringing with them anti-Muslim sentiments.[4839] Muslim scholars increasingly preferred to abandon the beautiful island, perhaps with regret, but realistically recognising that they could no longer share in the intellectual traditions of Islam under an alien regime.[4840] Muslims wanting official posts, for their part, had to change or conceal their faith.[4841] The massacres of Muslim urban elites took place in the early 1160s, as already seen. With the subsequent advent of the Angevin dynasty, the whole Muslim community was eradicated in the early 14th century. Subsequently, traces of Islamic remains were suppressed,[4842] and modern Western historians today continue to suppress this Islamic legacy.[4843]

[4835] Ibn Hawqal in J. D. Breckenridge: The Two Sicilies; op cit; pp. 43-4.
[4836] Ibid; p. 44.
[4837] Ibid.
[4838] S. P. Scott: *History;* vol 3; p. 2.
[4839] D. Matthew: *The Norman Kingdom of Sicily;* op cit, p. 92.
[4840] Ibid; p. 120.
[4841] Ibid; p. 88.
[4842] See part one, chapter on gardens and gardening, for instance, on the suppression of the Islamic legacy.
[4843] With rare exceptions, such as Bresc, for instance, modern writing on Sicily does away with its Islamic heritage, and poorly represents its history.

Spain:

In Spain, the Almoravids (late 11th century, followed by the Almohads, first stemmed the advance of the Christian conquest, and extended Muslim rule for nearly another two centuries (until the mid 13th century). Then, following the Almohads' defeat at Las Navas de Tolosa in 1212, Muslim power was broken in the Peninsula.[4844] It speeded the fall of Al-Nasir, the Almohad ruler, and began the disorganisation of the kingdom.[4845] Almohad Spain broke into small independent states, with ensuing civil wars between them, and general turmoil, which both demoralised the Muslims and invited Christian invasion.[4846] King James of Aragon marched into Valencia in 1238 to support one side of an Islamic civil war, part of a wider Muslim infighting.[4847] Years before, between 1229 and 1235, the Balearic Islands had fallen to James I.[4848] Cordova, the once mighty capital of Muslim Spain, likewise, weakened by Muslim infighting, fell easily in 1236. In 1246, Fernando III (1217-52), the King of Castile, occupied Murcia. Two years later, Seville, the Almohad capital, just like Cordova, fell victim to local Muslim infighting.[4849] To take the city Fernando was also greatly assisted by the military help of Mohammed 1st of Grenada, for Seville's Muslim inhabitants had put up a desperate resistance.[4850] The victorious Fernando III reunited Leon and Castile, pushed the Catholic frontier to Grenada, made Seville his capital, the Great Mosque his cathedral, and the Alacazar his residence.[4851] Subsequently, Muhammad II of Grenada also allied himself to Christian forces to rid himself of his Merinid co-religionist Abu Yusuf; an alliance between Castile and Grenada, which also resulted in the capture of the last Muslim stronghold: Tarifa (1275-76).[4852] Now the whole of Spain, except Grenada (which was to fall two centuries later in 1492), was in Christian hands.

[4844] B. Lewis: *Cultures in Conflict* (Oxford University Press; 1995), p. 19.
[4845] M.L. de Mas Latrie: *Traites de Paix.* Op cit; p.72.
[4846] R. I. Burns: Muslims in the Thirteenth Century Realms of Aragon: Interaction and Reaction, in *Muslims under Latin Rule*, (J.M. Powell ed); op cit. pp 57-102:p.73.
[4847] Ibid.
[4848] M.L. de Mas Latrie: *Traites de paix;* op cit; p.74.
[4849] Felipe Fernandez Armesto: *Before Columbus*; op cit; p.52.
[4850] Rodrigo de Zayas: *Les Morisques: et le racisme d'etat*; op cit; p.173.
[4851] W. Durant: *The Age of Faith*, op cit; p.697.
[4852] Rodrigo de Zayas: *Les Morisques*; op cit; p.174.

The Spanish Christian conquest turned out to be particularly bloody for the Muslims. The Chronicles of Alphonso VII say:

> 'The Christian armies pillaged all the land.... Set fire to all the villages they found, and destroyed their mosques; and all the men learned in religion that they found, they cut down with the sword; the vines and the olives and the figs and all the trees, they had cut down, and everywhere that their feet trod, they left devastated behind them.'[4853]

The Muslim city of Coria in June 1143 'was cleansed of the barbarian people and of the contamination of Muhammad.'[4854] Following the battle of Las Navas, in 1212, the Muslims of Baeza, who sought refuge in the Mosque were burned to death.[4855] In the same year, the population of neighbouring Ubeda, 70,000 Muslims, was either massacred or enslaved.[4856]

Mass cleansing of Muslim populations was also systematic. Initially, the Castilians generally followed a policy of sharing the towns with the Muslims and of keeping the structure of Islamic agriculture intact where possible (e.g., Toledo). But the policy changed radically with the capture of Baeza in 1226, after which Muslims were uniformly expelled from Andalusian towns and from much of the countryside as well.[4857] In 1247, James I ordered the expulsion of the Muslim from Aragon; over 100,000 of them left.[4858] Majorca also lost the larger part of its Muslims to flight and expulsion, whilst its smaller neighbour, Minorca had its population entirely enslaved.[4859] In the negotiations which preceded the capitulation of Seville, Fernando showed himself inexorable, and in order to make absolutely sure that Seville would remain in Christian hands, he had every Muslim leave the city, taking with them only what possessions they could carry, so that the city could be resettled by an exclusively Christian population.[4860] When the King of Castile made his formal entry on 22 December 1248, there stretched a ghost city of deserted tenements and

[4853] In N. Daniel: *The Arabs*, op cit, at p.85.
[4854] Luis Sanchez Belda, ed., *Chronica Adefonsi Imperatoris*; Madrid; 1950; book 2; chaps 151-4; 159-61; pp. 117-20; 123-5. in J.F. O'Callaghan: The Mudejars of Castile and Portugal in the twelfth and thirteenth centuries; in *Muslims under Latin rule;* op cit; pp. 11-56; at p.14.
[4855] J.F. O'Callaghan: The Mudejars; op cit; at p.15.
[4856] A. Thomson; M.A. Rahim: *Islam in Andalus; op* cit; p. 107.
[4857] On the significance of the capture of Baeza, Ubieto, Ciclos económicos, pp. 134-5; in T. Glick: *Islamic;* op cit. p. 100.
[4858] W. Durant: *The Age of Faith,* op cit; p.700.
[4859] R. I. Burns: Muslims in the Thirteenth Century Realms of Aragon; op cit; p.67.
[4860] R. Fletcher: *Moorish Spain* (Phoenix; London; 1992), p. 129.

streets, where those cats and dogs which had escaped being eaten during the siege scavenged among the bundles which had proved too much for the malnourished refugees to carry.[4861]
The quarters of the Muslims and the Jews in the towns and cities were also isolated. Walled compounds were established 'Juderias' for the Jews and 'Moreiras' for the Muslims, both of which were surrounded by a large wall and only had one entrance.[4862] Any Muslim who had not settled within the Moreiras within eight days had his property forfeited and was liable to whatever punishment the king saw fit, which often took the form of torture and death. Christian women were forbidden to enter the Moreiras (Moreria).[4863]

The economic impact of the 13th century loss of Islamic Spain was disastrous. In every conquered town and city, Muslims were generally removed to a suburb outside the main walls,[4864] and floods of Catalan settlers appropriated their lands.[4865] Around Seville, in Muslim times, more than 40,000 small farms once thrived on this land, using the water of the Guadalqavir for irrigating one of the richest regions in Europe.[4866] After the fall of Seville, Fernando III rewarded his Castilian nobility with such farms, dividing them between 200 of its members, forcing many of the Muslims to leave for North Africa.[4867] In Murcia, Alfonso continued to move Muslims out of the huerta and replace them with Christians.[4868]
Trade, initially controlled by Muslims and Jews passed under Christian hands as both groups were phased out. Aided by Christian military advances in the 11th and 12th centuries, Constable notes, European merchants began to exploit Mediterranean markets and routes previously controlled by Muslim and Jewish traders.[4869] Maritime routes along the east west trunk route that had once been the domain of Muslim and Jewish trade were gradually taken over by Christian shipping, or displaced by more northerly routes that shifted business away from Muslim ports.[4870] In contrast to the centuries of relative continuity in production, the period of Christian conquest from 1212 to 1248 marked a dramatic turning point for

[4861] Ibid.
[4862] A. Thomson and A. M. Rahim: *Islam;* op cit; p. 116-7.
[4863] Ibid.
[4864] R. I. Burns: Muslims; op cit; p.65.
[4865] Ibid; p.63.
[4866] R. De Zayas: Les *Morisques;* op cit; note 217- p. 677.
[4867] *Ibid.*
[4868] Repartimiento de la huerta y Campo de Murcia, in T. Glick: *Islamic;* op cit. p. 100.
[4869] O.R. Constable: *Trade and Traders;* op cit; p. 11.
[4870] Ibid.

Iberian trade.[4871] The incorporation of Mediterranean islands (including the Balearics, Corsica, Sardinia, Sicily and Crete) into the Latin Christian sphere allowed Italian, French, and Catalan shipping to control the safer and faster routes along the northern Mediterranean shores and avoid the reefs and contrary winds along the North African coastline.[4872] By the middle of the 13th century, Iberian trade was an almost exclusively Christian concern, and even the trade of Nasrid Grenada was largely controlled by foreign Christian merchants.[4873]

The Muslim communities of Spain fell under gradual and rising destitution following Christian conquest. What evidence there is, Lourie points out, suggests that both in Valencia and in Aragon, for instance, Mudejars (Muslims under Spanish Christian rule) were made to pay heavier rents than Christian tenants in the same village, quite apart from the special taxes they paid the Crown because of their infidel status.[4874] The Muslims had to pay '*pro peyta*' every year 200s.j. and a tithe on their flax, millet, wine and hemp to a certain Pedro Martinez de Luna. They also had to give him 'the same amount' of cereals and legumes 'as they annually sowed,' an appalling burden in view of the low productivity of the period.[4875] By the last decades of the 13th century, the burden of taxation had forced many Muslims communities in Aragon into a state of debt which may have become chronic.[4876] The same happened elsewhere. When they rebelled against such measures, as in Castile in 1264-66 and in Aragon in 1275-77, it gave their conquerors excuses to go back on undertakings made in earlier surrender agreements. In Valencia, for instance, the free Muslim peasant communities were forced to submit to 'seigneurialisation,' the imposition of burdensome dues and services which drove down their social status and their standard of living.[4877] Muslims who remained in the Kingdom of Valencia did so in mountainous regions where grazing and non intensive agriculture were

[4871] Ibid; p. 169.
[4872] These shifts are the theme of J. Pryor's Geography, Technology, and War: Studies in the Maritime History of the Mediterranean; 649-1571 (Cambridge; 1988), in O.R. Constable: *Trade and Traders*; op cit; p. 11.
[4873] O.R. Constable: *Trade and Traders*; op cit; p. 63.
[4874] E. Lourie: Anatomy of Ambivalence; Muslims under the crown of Aragon in the late thirteenth century; in E. Lourie: *Crusade and Colonisation; Muslims, Christians and Jews in Medieval Aragon* (Variorum; Aldershot; 1990), pp. 1-77. p. 16
[4875] Ibid.
[4876] Ibid; p.31.
[4877] R. Fletcher: *Moorish Spain;* op cit; p.143.

practiced.[4878] Add to this the apparatus of social and cultural disadvantage with which the Muslims were hemmed in, and so there arose 'a wounded subculture.'[4879]

Culturally, the Muslim losses amounted to worse. Their faith was targeted first. It was the regular practice for the Christian conquerors to convert mosques into churches; and the practice of taking over the principal mosque for Christian use effectively prevented the Muslims from maintaining their social cohesion by means of regular meetings, as an undivided community, for worship.[4880] Muslims were also jailed and tortured for refusing to eat pork or drink wine; neighbourhood gossip and surveillance were also introduced mainly to keep an eye on anyone whose clean and neat person betrayed that of a Muslim who regularly performed his 'ablutions'.[4881] In Aragon the local Christians made dunghills and built houses not only in the Muslim cemetery, which had existed as far back as memory went, but also in their mosque, whilst in Saragossa, the Muslim cemetery was also used as a cesspit, and even a brothel was opened in the Moreria.[4882] Those amongst Muslims who sought to convert to Christianity to improve their condition soon realised its worthlessness. At the Valencia riots of 1275, they paid as high price in blood as those who had remained Muslim: the Muslim, convert to Christianity, or not, was still alien.[4883]

A series of regulations and edicts pressured the Muslims on a legal level; physical elimination, as always, preceded by legal restrictions and measures, as Daniel points out.[4884] Regulations in the way Muslims ought to dress were introduced to help Christians recognize Muslims on sight and thus keep their distance from them.[4885] To prevent Muslims from presenting themselves as people of high social positions, the Cortes of Seville in 1252 (art.40) forbade Muslims living in Christian towns to wear certain types of clothing or certain colours.[4886] These were extensions to measures introduced earlier. In 1216, the Church Latheran Council passed a measure which obliged both Muslims and Jews to wear distinctive garb,

[4878] T. Glick: *Irrigation and Society in Medieval Valencia* (Cambridge mass; 1970), p. 231, ff.
[4879] R. Fletcher: *Moorish Spain;* op cit; p.143.
[4880] Ibid.
[4881] T.B. Irving: Dates; op cit. p. 81.
[4882] E. Lourie: Anatomy of Ambivalence; op cit; p. 52.
[4883] R. I. Burns: Muslims in the Thirteenth Century; op cit;p.79.
[4884] N. Daniel: *The Arabs*, op cit; p.254.
[4885] J. F. O'Callaghan: The Mujedars of Castile and Portugal; op cit; p.30.
[4886] Ibid.

and that meant not just daily humiliation, but also exposure to attacks and murder especially during travel on the insecure high roads.[4887] *The Leyes del estilo*, compiled in the late 13th-early 14th century for use in the Castilian royal court, stipulated that the fine for killing a Muslim should be in accordance with local custom, but should not be as great as the fine for Killing a Christian.[4888] If custom is to be followed, the earlier *fuero* of Najera in 1076 fixed the fine for killing a Muslim at twelve and a half *solidi*, half the cost of a cow and equal to that of an ass.[4889]

On the scholarly level, the first wave of Christian conquest (mid-late 11th century) decimated Islamic scholarship. The historian Ibn Bassam describes how the incessant invasions of the Christians forced him to flee from Santarem in Portugal 'the last of the cities of the West,' after seeing his lands ravaged and his wealth destroyed, a ruined man with no possessions save his battered sword.[4890] Many scholars such as Abu Salt of Denia, and Abu Behr al-Tortuchi of Tortosa left Spain altogether to take refuge in Egypt, whilst others were much less fortunate, like the poet Ibn Wahbun, who was murdered by Christian raiders on the road from Lorca to Murcia in 1087.[4891] The Almoravid-Almohad intervention (late 11th-mid 13th century) brought back security and a flurry of Islamic scholarship. In the wake of the second and ultimate round of Spanish conquest (1220s-1260s), Islamic scholarship was destroyed for good. The permanent loss of the great Muslim centres of civilisation: Seville, Cordova, Valencia, Murcia, Jaen, etc, resulted not just in decadence, but in fact to a virtual obliteration of Muslim science and civilisation.[4892] It meant the loss of Cordova, the centre of Muslim civilisation in the West; the loss of Xativa and its paper industry; the loss of Valencia and its arts and crafts; the loss of city ports and their once flourishing trade and shipyards; the loss of libraries and schools, and much worse, the severe, and irretrievable loss of Muslim elites.[4893] Ibn al-Baytar (1197-1248), Sarton notes, was one of the last sole 'heroes' of the period, which symbolises the relative decline of that country.[4894]

[4887] A. Thomson and A. M. Rahim: *Islam;* op cit; p. 115.
[4888] J. F. O'Callaghan: The Mujedars of Castile; op cit; p.39.
[4889] Ibid.
[4890] C. Dawson: *Medieval Essays* (Sheed and Ward: London; 1953), p. 129.
[4891] Ibid.
[4892] T. Glick and O. Pi Sunyer: Acculturation as an explanatory concept in Spanish history; in *Comparative Studies in Society and History*; XI (1969) 136-54; at P.143.
[4893] R. Fletcher: *Moorish Spain;* op cit; p.143.
[4894] G Sarton: *Introduction;* Vol II, op cit; p. 485.

No place better symbolises the significance of the loss of Spain for the Muslims than Seville. Seville was not only one of the leading cities of Spain, but 'one of the most enlightened cities of the whole world.'[4895] If one names at random the philosophers al-Baytalyusi and Ibn Bajja, the astronomer Jabir ibn Aflah, the geographer Muhammad al-Zuhri, the physicians of the Ibn Zuhr family, the historian Ibn Bashkuwal, and the jurists Ibn al-Arabi and Abu Bakr al-Turtushi, Ibn Tumart… most of these men; Sarton notes, lived and worked for a time in Seville.[4896] It was also Seville, which gave that great figure of astronomy, al-Bitruji, who wrote in 1180 '*Kitab-al-Hay'ah*', translated by Michael Scot under the title 'On the Sphere,' which was to provide suggestions to Copernicus.[4897] Also in Seville worked the great mathematician, Ibn al-Yasamin (d. 1204), of black African origin,[4898] and the great instrument maker, Mohammed B. Fatuh (fl early 13th century.)[4899] Summing up the city's Muslim glory Al-Shaqundi, in his *risala*, says:

> 'I have also heard of the magnificence and good design of its buildings; most of which, not to say all, are abundantly provided with running waters, and spacious courts planted with fruit trees, such as oranges, the lemon, the lime, and the citron tree. The sciences and the arts are cultivated with more or less ardour, with more or less success; the number of their authors is indeed too considerable to be stated, and their writings too well known to need description.'[4900]

And what it meant to Islam to lose Andalusia is caught nowhere better than in these lines from the poet Ar-Rundi:

> 'Ask Valencia what became of Murcia,
> And where is Jativa, and where is Jaen?
> Where is Cordoba, the seat of great learning.
> And how many scholars of high repute remain there?
> And where is Seville, the home of mirthful gatherings
> On its great river, cooling and brimful with water?
> These cities were the pillars of the country:
> Can a building remain when pillars are missing?
> The white wells of ablution are weeping with sorrow,

[4895] Ibid. p.148.
[4896] Ibid.
[4897] C. Singer: *A Short History of Scientific Ideas to 1900* (Oxford University Press; 1959), p.154.
[4898] A. Djebbar: Ibn al-Yasamin; in *Encyclopaedia*; (Selin Ed) op cit; pp. 414-5.
[4899] L.A. Mayer: *Islamic Astrolabists and their Works* (Albert Kundig; Geneva; 1956), p. 64.
[4900] Al-Shaqundi; *Risala*, in Al-Maqqari: *Nafh Al-Tib*; op cit; p.56.

> As a lover does when torn from the beloved:
> They weep over the remains of dwellings devoid of Muslims
> Despoiled of Islam, now peopled with Infidels!
> Those mosques have now been changed into churches,
> Where the bells are ringing and crosses are standing.
> Even the mihrabs weep, though made of cold stone,
> Even the minbars sing dirges, though made of wood!
> Oh heedless one, this is fate's warning to you:
> If you slumber, Fate always stays awake.'[4901]

The Muslims never recovered Spain and Sicily again, in fact losing their last presence in Grenada in 1492. The Inquisition then caught, tortured and sent countless Muslim 'Infidels' to be burnt at the stake.[4902] Eventually, in 1609-10, Muslims were wiped out of Spanish soil.[4903]

d. Timur (1398-1402):

When he died at the age of 74, in the year 1405, Armesto notes, Timur had conquered Iran, wrecked the khanate of the Golden Horde, reduced the Jagaite state to a rump, halted the growth of the Ottoman empire, and caged its sultan, invaded Syria and India. 'The marks of his passing, wherever he went lands were devastated, heaped up skulls of people.'[4904] From this brief outline by Armesto it is already obvious that Timur, single handed, devastated the Islamic world that had begun to recover in places from the Crusader-Mongol onslaughts. Further misdeeds of his, to be seen further on, will explain why the Muslim world remained broken, unable to resist subsequent invaders. Despite this, and despite giving ample accounts of Timur's devastation of the land of Islam, Jean Aubin, like almost all Western scholars, still writes in great praise of the accomplishments of what he, like the rest, calls 'the Great Man.'[4905] Hence, Aubin, for instance, says:

[4901] In R. Fletcher: *Moorish Spain;* op cit; pp. 129-30.
[4902] H.C. Lea: *A History of the Inquisition;* op cit.
[4903] See: S. Lane Poole: *The Moors;* op cit; S.P. Scott: *History;* op cit; J Read: *The Moors;* op cit; H.C. Lea: *The Moriscos;* op cit; etc.
[4904] F. F. Armesto: *Millennium;* Touchstone Publishing (Simon and Shuster New York; 1995), p. 115.
[4905] J. Aubin: Comment Tamerlane Prenait les Villes; in *Studia Islamica*; Vol 19; pp. 83-122.

> 'Timurid chroniclers derive from the life of the Great Man moral lessons, and lessons of statesmanship…. Authentic accounts of him they convey to us, do not show a fanatic Muslim, but instead reveal to us a very constructive character.'[4906]
>
> 'A military genius, Timur was also a great statesman, just as great leaders are….'[4907]
>
> 'We are not surprised that, professing his Muslim faith, still the Great Emir allowed his soldiers to soil, without any qualms, the mosques.'[4908]

Then, after going through the widespread massacres of Muslims by Timur, Aubin still manages to refer to 'the Great Emir's 'moderation' on his way back to his land at Bira, Ruba, and Nisbin (because he did not put them to the sword and fire.)'[4909]

Then, justifying Timur's lust for blood and his depraved manner in erecting pyramids, minarets and mountains of skulls of populations he had slain, and the widespread trampling of children by his horsemen, Aubin concludes:

> 'Barbarism is natural to Cagatay warriors, in the history of the Orient, which suffered other terrible woes… the Great Emir marked it (such history) with the most outstanding features of his temperament: the taste for order and the taste for the colossal.'[4910]

Aubin's admiration for Timur is similar to that shown by nearly all Western historians for other mass slayers of Muslims such as Genghis Khan, or Hulagu, and that can be found in nearly every work on them today. An admiration, which perhaps comforts such historians but fills the decent with revulsion at the horrors they inflicted on the Muslim land, just as Timur did.

It was in the 1380s, that Timur began his devastation of the Muslim realm. In December 1383, Shar-I Sistan is returned to the desert and four years later, 70,000 heads were chopped off in Ispahan; the following year, Khwarism is emptied of its population, and where once Urgang stood, now had become farmed land.[4911] Zaranj the capital of the province of Seistan, suffered a terrible fate, its population slaughtered, its dams and all

[4906] Ibid; p. 85.
[4907] Ibid; p. 85.
[4908] Ibid; p. 85.
[4909] Ibid; p. 97.
[4910] Ibid; p. 121.
[4911] Ibid; p. 83.

its irrigation works completely laid waste.[4912] A similar fate befell the Band-I-Rustam, and the region of Bust.[4913] In Siwas, Timur had 120,000 people massacred.[4914] In Tus, in 1388, Timur's general, Miran Shah, gave the order to loot the city, first, then, he ordered each soldier to bring him the head of one person from the city, and after all men were killed, they slew, en masse, old women and children, then, he constructed minarets of skulls.[4915] Also in Tus, Timur's hordes dragged its female population out of the city, pulling them by their hair, women 'whom the shade of the Sun had never tarnished.'[4916]

In 1388 Timur invaded Muslim northern India, and ten years later sacked Delhi, massacred its inhabitants, and carried the treasure of the sultans home to Transoxania.[4917] Ten years later, in the month of December, Timur gave orders for tens of thousands of prisoners of Indian Muslims to be slaughtered, and that any of his soldiers who failed to kill his quota was to be slain and his family sold into slavery.[4918] Someone travelling through the India of 1400, Wolf observes, would have found many cities in ruin.[4919]

In Muslim southern Russia, in 1395, all able women and girls were taken into slavery. All over the devastated land, contemporary accounts are all in agreement about the brutal mass rapes of women, girls and boys, generally in front of the rest of their families.[4920]

Timur, then, turned his attention to the Arab East. It is needless to dwell beyond the shortest of outlines on all the mass killings, mass rapes, and wholesale devastation that Timur inflicted on Iraq and Syria. In Tikrit, in 1393, just as elsewhere, he had the whole male population slaughtered.[4921] Baghdad, which had just begun recovering from the Mongol devastation was now finished off, pitilessly slaying its whole population, and erecting pyramids of their skulls.[4922] There, as elsewhere (Shar-I-Sistan, Ispahan,

[4912] N. Smith: *A History*, op cit, p 86.
[4913] Ibid.
[4914] E. Pears: The Ottoman Turks to the fall of Constantinople. In *The Cambridge Medieval History* (Cambridge University Press, 1923), Vol IV: Edited by J. R. Tanner, C. W. Previte; Z.N. Brooke, 1923. , pp 653-705. pp. 679-80.
[4915] J. Aubin: Comment; op cit; p. 116.
[4916] Hafis-I Abru; p. 87; in J. Aubin: Comment; op cit; p. 107.
[4917] E.R. Wolf: *Europe*; op cit p. 45.
[4918] Yazdi; 2; 92; in J. Aubin: comment; op cit; p. 106.
[4919] E.R. Wolf: *Europe*; op cit; p. 45.
[4920] Such as in Ispahan; Khwarizm, and elsewhere in J. Aubin: Comment; op cit; p. 107.
[4921] J. Aubin: Comment; op cit; p. 116.
[4922] E. Gibbon: *The Decline and Fall*; op cit; pp. 55-6.
Sir Edwin Pears: The Ottoman Turks; op cit; pp.679-80

Sivas…), infants and children were generally crushed to death under the feet of horses.[4923]

Then Timur fell on Syria. Here is the narration by Gibbon:

> 'Timur entered Aleppo. Among the suppliants and captives, Timur distinguished the doctors of the law, whom he invited to the dangerous honour of a personal conference… During this peaceful conversation the streets of Aleppo streamed with blood, and re-echoed with the cries of mothers and children, with the shrieks of violated virgins. The rich plunder that was abandoned to his soldiers might stimulate their avarice; but their cruelty was enforced by the peremptory command of producing an adequate number of heads, which, according to his custom, were curiously piled in columns and pyramids: the Moguls celebrated the feast of victory, while the surviving Moslems passed the night in tears and in chains. I shall not dwell on the march of the destroyer from Aleppo to Damascus… Abandoned by their prince, the inhabitants of Damascus still defended their walls; and Timur consented to raise the siege, if they would adorn his retreat with a gift or ransom; each article of nine pieces. But no sooner had he introduced himself into the city, under colour of a truce, than he perfidiously violated the treaty; imposed a contribution of ten millions of gold;… and after a period of seven centuries, Damascus was reduced to ashes.. In his return to the Euphrates he delivered Aleppo to the flames… but I shall briefly mention that he erected on the ruins of Baghdad a pyramid of ninety thousand heads.'[4924]

Having ravaged Syria, slain its adult population, and taken East the greatest numbers of women as slaves, infants deprived of adult care, were left behind to starve to death in considerable numbers.[4925] On Syria he had just inflicted 'a mortal blow.'[4926]

In his wholesale orgy of slaughter and destruction, Timur spared only one group: craftsmen, including glassmakers, whom he carried to Samarkand in central Asia.[4927] The deportation of the glassmakers from Damascus in 1400 is believed to have put an end to the manufacture of gilded and enamelled vessels in western Asia.[4928]

[4923] J. Aubin: Comment; op cit; pp. 116-7.
[4924] E. Gibbon: *The Decline and Fall of the Roman Empire*; op cit; pp 55-6..
[4925] Ibn Hagar; fol 173b; in J. Aubin: Comment; op cit; p. 107.
[4926] G. Sarton: *The Incubation;* op cit; Note 35; p.35.
[4927] D. Whitehouse: Glass; op cit; p. 547.
[4928] Ibid.

All over the Muslim land, from Ispahan, to Tus, Delhi, Aleppo, Baghdad, Timur erected minarets of skulls, sometimes towers of skulls, surrounding cities, over fortresses, and on top of mountains,[4929] everywhere, corpses decomposing, so as to serve, Aubin merrily notes, 'to remind the survivors of the wrath that would befall upon those who rebelled or were the authors of provocations.'[4930]

Then, to finish his deeds, Timur launched an attack from the rear against the Ottomans, defeating, capturing, and caging to death their mighty leader Bayazid, once the Thunderbolt of Islam.[4931]

e. Shared Impact of Invasions:

The Muslim world was thoroughly devastated by these invasions. A demographic catastrophe was the first outcome. The population of Syria, for instance, was almost wholly decimated.[4932] At the time of the crusades its population stood at 2.7 million inhabitants.[4933] An Ottoman census of 1519 in what is today Syria and Israel/Palestine shows fewer than 600,000 people living in an area that probably had a population of about 4 million in the days of the Muslim Caliphate (before crusades, Mongols and Timur).[4934] This means a near total extinction. Further east, the same. Nishapur, taken here as an instance, captured by assault in April 1221 by the Mongol Tolui, became a scene of carnival of blood scarcely surpassed in Mongol annals, as separate piles of heads of men, women and children were built into pyramids, and even the cats and dogs were killed in the streets.[4935]

It is the generalised practice, though, of modern Western historians to minimise Islamic losses. This is the case whether for the recent genocides such as in Bosnia (1992-95),[4936] or the less recent ones such as the Algerian casualties from French colonisation (1830-1962), or the mass

[4929] J. Aubin: Comment; op cit; p. 119.
[4930] Ibid; p. 120.
[4931] William Miller: The Balkan States; *The Cambridge Medieval History,* Vol IV: Edited by J. R. Tanner et al; op cit; pp 552-593. p.562.
[4932] Y Courbage, P Fargues: *Chretiens*; op cit; p. 35.
[4933] Josiah Cox Russell: late Ancient and Medieval Population, In Y. Courbage-P. Fargues; op cit. p. 35.
[4934] R.A. Rotz on J. J. Saunders: *A History;* op cit.
[4935] J.J. Saunders: *The History of the Mongol Conquests;* op cit; p. 60-1.
[4936] See recent editions in the Media or reviews such as Marxism Today, which even deny aspects of such genocides.

extinction of Muslims in Spain, especially in the years 1609-1610,[4937] and the medieval havoc caused by the crusader-Mongol onslaught. Such genocides when acknowledged are even attributed to the Muslims themselves. Ashtor, for instance, blames the destruction, decline of numbers that occurred in the crusades period on the Seljuk, as extracts here show:

> 'The countless passages where the chronicles speak of the tyranny and the cruelty of the Turkish princes leave no doubt to the plight of Oriental townspeople in the Seljuk age. There must surely have been a general decline of prosperity, and as a consequence of misgovernment and poverty was a decrease of population.'[4938]
>
> 'The decrease of population was not only a quantitative decline. It was a permanent bleeding, a self destruction of the ruling class. Reading the Arabic chronicles carefully one becomes aware of the really catastrophic consequences of the Turkish military of drunkenness... Surely the caliphs and other Muslim rulers in former times drank, too, but it seems that in this period it became a more general phenomenon, as far as the upper classes, the elite, are concerned. Undoubtedly the Turks had brought the custom of drinking from their homelands in the cold regions of Central of Asia. One consequence was probably rather limited procreation.'[4939]

The Mongols only killed 100,000 people says Ashtor, who adds:

> 'The blood letting that accompanied the Mongol conquest was followed by a sort of recovery. The administration of Iraq by Ata Malik Djuwaini, who held his post for 24 years (1258-82), brought relief to the sorely afflicted country.'[4940]

Of course Ashtor is telling fallacies, for every contemporary source, whether Christian or Muslim, speaks of the mass slaughter of the Muslim population by the crusaders. Furthermore, Baghdad, as amply demonstrated already in part one, did not contain 100,000 people, but over a million.

A generalised technique to cut the numbers of Muslim victims of such genocides in history is to cut down the Muslim population prior to the killings in the first place. Russell, for instance, as Watson notes, cuts down the population of early Islamic towns and countryside by assuming that the figures for cities must refer to the whole provinces; by using

[4937] As in H. Lapeyre: *Geographie de l'Espagne Morisque* (SEVPEN, 1959).
[4938] E. Ashtor: *A Social*; op cit; p. 217.
[4939] Ibid; p. 221.
[4940] Ibid. 251.

excessively low multipliers for the size of household or the number of inhabitants per hectare; by supposing that the population of metropoles was a constant proportion of the population of the hinterland, by concluding that accounts of tax returns which speak of dinars must have meant dirhems, etc.[4941]

Reifenberg and others, as Watson also demonstrates, also distort the picture by asserting that settlements were abandoned in Palestine or Syria following the Muslim arrival.[4942] This is false, for evidence shows clearly that these parts were abandoned, instead, either before the Muslim arrival, or more importantly, in relation to the Syrian regions, which escaped crusader onslaught, such as Aleppo, for instance, that they were densely populated and prosperous in Muslim times, and were emptied only in the 13th century following the Mongol invasions.[4943]

The real scale of the bloody and demographic havoc caused by the crusaders and Mongols, which modern historians, in general distort, can, however, be fully caught in accounts by contemporary historians, whether Muslim or others.[4944]

Centuries of mayhem and slaughter had a terrible repercussion on the local economies, as it meant there was hardly any labour force left to maintain land, irrigation works, or other labour intensive tasks in any part of the Islamic world. Everywhere, the rural economy was in retreat.[4945] In the East, following the Mongol invasions, the once prosperous and essential agro-industries, such as sugar, were completely devastated.[4946] In

[4941] Josiah Cox Russell: Late Ancient and Medieval Population, op cit;
A.M. Watson: A Medieval Green Revolution; op cit; Note 45; p. 56.
[4942] A. Reifenberg: *The Struggle Between the Desert and the Sown* (Jerusalem; 1955), pp. 55-7; 97.
C. Tchalenko: *Villages Antiques de la Syrie du Nord* (Paris; 1953-8), Vol 1; pp. 431-8.
A.M. Watson: A Medieval Green Revolution; op cit; Note 42; p. 55.
[4943] See J. Sourdel Thomine: Le peuplement de la region des villes mortes (Syrie du Nord) a l'epoque Ayyubide; *Arabica*; I; 1954; pp. 187-200.
[4944] Such as from:
The First and second Crusades from an Anonymous Syriac Chronicle: Translated by A.S. Tritton; with notes by H.A.R. Gibb; *Journal of The Royal Asiatic Society (JRAS)* 1933; pp 69-101.
Ibn al-Athir: *Kitab al-Kamil*; op cit.
Gesta Francorum et aliorum Hierosolimitanorum, ed. K. Mynors, trans. R.Hill (London, 1962).
William of Tyre: *A History of Deeds Done beyond the sea*; 2 Vols; trans and ed by E. Babcock and A.C. Krey (New York; Columbia University Press; 1943), repr 1976;
[4945] See A. Watson: *Agricultural Innovation*; op cit; Chapter twenty Five: Agriculture in retreat.
[4946] N. Deerr: *The History;* op cit; vol 1; p. 72.

the lands overrun by the Christians: Spain, Sicily and also the East, the appearance of the Christians caused Muslim peasants to flee, leaving large tracts of *agri deserti* and a great deal of other land which, though not completely abandoned, came to be farmed less intensively.[4947] The fate of the peasants who fell under occupation continually worsened as they were reduced to a kind of serfdom and made liable to heavier payments.[4948] In Sicily, Ibn Jubayr reports that wealthy Muslims were active in the work of buying back men enslaved for their faith, but they did not or could not do much for their co-religionists in the countryside whose lot seemed to him thoroughly pitiable.[4949] Those who escaped remained mainly in mountain regions where grazing and extensive agriculture were practised.[4950] The flight of peasants continued intermittently for some centuries after the conquests as a result of local persecutions by the Christians and unsuccessful uprisings by the Muslims.[4951] Muslim peasants were replaced by immigrants from the heartland of Europe, whose farming skills were inferior to those of the Muslims.[4952]
As for the beauty of gardens, it soon died, too; the passion for greenery of early Islam soon to be extinguished to leave way to barrenness.

The once thriving Muslim culture and scholarship disappeared, too. Everywhere, Muslim scholars caught by the invaders were slain. On the taking of Jerusalem, for instance, hardly any of the learned, whose numbers thrived prior to the crusades, survived. They suffered fates like that of al-Rumayli, the most celebrated Palestinian hadith expert of his age and author of tracts on the merits of Jerusalem and Hebron, who was stoned to death.[4953] Others, such as Abd Al-Djabbar B. Ahmad of Isfahan were also killed in the same city.[4954] The names of many scholars slain by the Mongols have been left to us, names such as Najib al-Din Al-Samarkandi, killed during the Sack of Herat in 1222-23.[4955] Also killed

[4947] A.M. Watson: *Agricultural*; op cit; p. 144.
[4948] A.M. Nanai: L'Image du croise. Op cit; p. 20.
[4949] D. Matthew: *The Norman Kingdom of Sicily;* op cit; p. 88.
[4950] T. Glick: *Irrigation*; op cit; pp. 231 ff.
[4951] J. Prawer: *Histoire du Royaume; Latin de Jerusalem;* 2 vols (Paris; 1979), I. Peri: *Cittae e campagna in Sicilia*; 2 vols (Palermo; 1953-6), vol 1; pp. 40-1; etc.
[4952] A. Watson: *Agricultural;* op cit; p. 144.
[4953] B. Z. Kedar: The Subjected Muslims of the Frankish Levant, op cit.143.
[4954] Mudjir Eddin: *Al-Euns al-jalil bi Tarikh el-Qods wa'l Khalil*, translated into French as Histoire de Jerusalem et Hebron, by H. Sauvaire (Paris; Ernest Leroux; 1875; and 1926), p. 299.
[4955] G. *Sarton: Introduction*; op cit; vol II; p.661.

was Al-Jaghmini (d. 1221), one the greatest Islamic mathematicians of the East.[4956]
In Spain, the only Muslim artistic elite which remained under Christian rule, were men (and women) whose creative genius did not depend on language, and could avoid the political implications inevitable in verbal discourse; in short, masters of the decorative and architectural arts, painters, plasterers, woodcarvers, ceramicists and builders; in those areas, there was no anomaly in receiving Christian patronage.[4957] The sole field of scholarship which offered a living to a mudejar (a Muslim under Christian rule) was medicine, for it too was a craft rather than a form of discourse; yet though there were a few mudejar doctors and many mudejar surgeons, it was probably no coincidence that when a scholar at Lerida needed copies of certain medical books in Arabic, Jews and not Mudejars were expected to have them; and a popular Muslim eye specialist practicing in Vilafranca del Penedes was a slave, who had obviously been trained elsewhere.[4958] Similarly, when Ramon Lull decided to learn Arabic, it was not a mudejar who became his tutor, but a slave whom he had bought specially to teach him.[4959]

Libraries, once the glory of Islam, were almost all destroyed by the vandalism of the invaders.[4960] The libraries of the East were victims of the crusaders and the Mongols. The barbaric behaviour of the crusaders, during the first crusade in particular, Erbstosser insists, was a serious blow for the schools and libraries of the East.[4961] The first Mongol invasions (1219-21), were so destructive that from then onwards, we do not hear of a single library in those parts they had invaded.[4962] Before its sack, Merw was filled with libraries, scientists and writers; after the devastation it 'became a dwelling for the owl and the raven.'[4963]
In Baghdad, Ibn Said al-Maghribi, in his geographical treatise, referred to the thirty six libraries which he had visited in Baghdad before the Mongol

[4956] B. Rosenfeld and E. Ihsanoglu: *Mathematicians, op cit;* pp. 198-9.
[4957] E. Lourie: Anatomy of Ambivalence; op cit; p. 50.
[4958] For Mudejar and Morisco surgeons, see L. Garcia Ballester: *Los Moriscos y la medicina* (Barcelona 1984).
[4959] E. Lourie: Anatomy of Ambivalence; op cit; p. 50.
[4960] For more on the destruction of Islamic libraries, see, for instance:
-J. Pedersen: *The Arabic Book;* op cit. S.P. Scott: *History*, op cit; A Shalaby: *History*; op cit; W. Durant: *The Age of Faith*; op cit;
[4961] M. Erbstosser: *The Crusades;* op cit; p. 149.
[4962] W. Heffening: Maktaba; Encyclopaedia of Islam; op cit; vol 6; p. 198.
[4963] Yaqut al-Hamawi, author of the Dictionary of the Learned Men, quoted in M. Levey; N. Al-Khaledy: Chemistry in the Medical Formulary of al-Samarqandi; *Chymia*; vol 11; pp. 37-44. p.37.

invasion (of 1258).[4964] They were all levelled to the ground by the Mongols.[4965] The literary and scientific treasures, accumulated over the centuries, were destroyed.[4966] The great library was burned, and its books and manuscripts thrown into the Tigris River, and they were so numerous that they filled the river from bank to bank like a bridge.[4967] Of the great masterpieces in the Baghdad libraries, not one in a thousand exists today, even in the most fragmentary form.[4968] Not only were these accumulated treasures destroyed, but nearly all of the scholars and learned men were pitilessly murdered.[4969]

In the West, when the Christians retook Cordoba in 1236, they burnt its mighty library,[4970] and other fires consumed Muslim scholarship in the decades and centuries to follow, including that infamous mass burning of Islamic books ordered by Cardinal Cisneros in the wake of the taking of Grenada (1492). What books were saved found lodgement in libraries in Fes or Tunis.[4971] In the sack of Tunis in 1536 by Emperor Charles V, all books written in Arabic were burned.[4972] Spain was so stripped of Muslim books that when Philip II, in the 16th century, founded the Escorial library, he was unable to find many Arabic books in Spain.[4973] Some survived in Morocco, and the capture of a Moroccan galley, allowed a collection gradually to be built up.[4974] A 17th century catalogue of the Escorial library, then the largest in Spain, showed only 4,000 Islamic titles, last survivors of one of the worst holocausts of books in history.[4975] However, later, in June 1674, a fire broke out at the Escorial and destroyed 8,000 books in Arabic, and a century later, when Michael Casiri began to catalogue the Arabic collection in the Escorial, he found only 1,824 manuscripts, forlorn survivors,[4976] a mass burning of books from Spain to the far eastern boundaries of Islam, which wiped out almost the entire Islamic heritage.[4977]

[4964] G. Sarton: *Introduction*; op cit; vol 2. p.796.
[4965] J. Pedersen: *The Arabic Book,* op cit, p. 128.
[4966] R.H. Major: *A History of Medicine*; op cit; p. 258.
[4967] Ibid.
[4968] Ibid.
[4969] Ibid.
[4970] S. Watts: Disease and Medicine; op cit; p. 40.
[4971] S.K. Padover: Muslim Libraries; op cit; p. 368.
[4972] Ibid.
[4973] F.B. Artz: *The Mind,* op cit; p. 153.
[4974] S.K. Padover: Muslim Libraries; op cit; p. 368.
[4975] F.B. Artz: *The Mind*; op cit; p. 153.
[4976] S.K. Padover: Muslim Libraries; op cit; p. 368.
[4977] See, for instance, M. Nakosteen: *History*; op cit; M. Sibai: *Mosque Libraries*; op cit; and J. Pedersen: *The Arabic Book;* op cit.

Add to this the loot and destruction of rare and multiple Islamic books during the modern colonial period (late 18th-1960s),[4978] and one realises why nearly nine out of ten of the once great Muslim library works are lost, and one also realises what a great accomplishment Muslim civilisation was, when one knows that today, hundreds of thousands, millions, possibly, of Muslim manuscripts still survive scattered all over the world.[4979] One ponders on this great civilisation that, in medieval times, at the height of the theocratic Islamic state, was able to produce countless millions of works; a civilisation, which modern scholarship, in its excellence at combining extreme hostility to, and pure ignorance of, its subject, labels fanatical, and inimical to books and learning.

Final Words on the Devastation of Invasions:

Travelling through the Islamic realm (late 12th century) Ibn Jubayr caught the state of the Islamic land as it began to crumble. He saw Acre in Crusader hands, and says:

> 'The Franks wrested it from the hands of the Muslims.... Islam wept grievously for it.... It burns with unbelief and tyranny, boiling over with pigs and crosses. The city is filthy and squalid and all of it is filled with dirt and shit.'[4980]

And so was the city of Messina in Sicily, now in Norman hands:

> 'Messina is overcast through unbelief; no Muslim resides there. It is laden with cross worshippers... and is full of stench and dirt.'[4981]

Subsequent travellers through the Muslim land would only see ruins on much of the land-an Islamic land devastated by the invader, ultimately ruined by Christian pirates.

[4978] See, for instance, G. Le Bon: *La Civilisation des Arabes;* op cit; pp. 480 ff.
[4979] A glimpse of this is offered for Muslim astronomers and mathematicians by B. Rosenfeld and E. Ihsanoglu: *Mathematicians,* op cit.
[4980] Ibn Jubayr: *The travels of Ibn Jubayr*; translated from the original Arabic with introduction and notes, by R.J. C. Broadhurst (Jonathan cape, London, 1952), at pp 136; 276.
[4981] Ibid; p. 296.

3. Piracy and the Impoverishment of Islamic Society Down to the Colonial Age:

Braudel asks a number of questions on why Islamic civilisation came to a sudden halt:

1) Was it because of al-Ghazali, who had suffocated freedom of thought?

Braudel answers negatively, explaining that Muslim philosophy survived al-Ghazali (i.e Ibn Rushd., Ibn Tufayl etc.)

2) Was it the fault of the barbaric Berber Almohads?

Again, the answer is negative, as the Almohads had a brilliant civilisation, and they protected and sponsored scholars.

3) Or maybe the Turks, or any other Islamic group were the causes of such decline?

No, is the answer.

The true reason for the Islamic decline, Braudel concludes, was the destruction of the Muslim Mediterranean trade; in effect Pirenne's theory reversed.[4982]

Braudel remains one of the rare names to explain Islamic decline in these terms. And even he fails to offer the big picture. Indeed, one goes further than him to add that the destruction of the Muslim Indian Ocean trade over the same period as that of the Mediterranean trade were the crucial factors in the impoverishment of the Islamic world prior to colonisation, which only finished the job.

a. The Destruction of the Muslim Mediterranean Trade and the North African Economies Down to the 16th Century:

During the Middle Ages, Lethaby says, what filled the minds of makers and listeners in Western Christendom were Caliphs and Emirs, Arabs, Turks, and Saracens 'who had nothing white but their teeth; Spain, Africa, Egypt, Persia, Cordova, Toledo, Seville, Palermo, Babylon, and Alexandria with its harbours and ships; silk from Alexandria, gold from Arabia, embroideries, 'olifants' and ivory chairs, helmets and swords

[4982] F. Braudel: *Grammaire des Civilisations* (Flamarion, 1987), p. 117.

ornamented with carbuncles, saddles covered with gold and gems, painted shields, bright gofalons."[4983]

As Braudel also explains, in the 10th century, contrary to a subsequent epoch, the rich was the Muslim, and the poor was the Christian.[4984] However, as Braudel adds: it is 'The destiny of the rich to become prey and temptations for the poor."[4985]

In the 11th century, most of the northern pirates who descended on the coasts of Muslim Spain came from the British Isles, 'Anglici piratae', they were called by contemporary historians.[4986] After the Normans took Sicily (1060-91), the Muslims did not just lose a thriving island, but also, from Sicilian port cities, Norman boats relentlessly chased after Muslim merchant boats. Soon Christian pirates began disembarking in North Africa, destroying warehouses in a series of murderous assaults.[4987] Towns and cities were set upon, ransacked, and burnt down, their populations slaughtered. In 1135, Roger of Sicily sent a force of Frankish knights and Muslims from Sicily to Gerba, in Tunisia. The place was ravaged, its population slaughtered in great numbers, the rest reduced to servitude, and put under the rule of a Muslim *amil* (stooge).[4988] In 1141-2, with famine and plague decimating the Tunisians, Roger demanded that his agents be paid what the emir owed them; when the latter failed, Roger intervened, and his navy confiscated Egyptian boats at El-Mehdia, besides imposing new tributes on the Tunisians.[4989] Another attack under the same Roger in 1146 with a fleet of 200 ships under the command of George of Antioch managed to capture the city of Tripoli after three days of fighting, followed by several days of plunder.[4990] In 1148, Al-Mehdia fell to the Normans, and so did Susa, Sfax, the dominion of the Normans now extended from Tripoli to the borders of Tunis, and from the western Maghrib to Al-Qayrawan.[4991] Roger sought to extend his dominion

[4983] W.R. Lethaby: Medieval architecture: in *The Legacy of the Middle Ages*, edited by C.G. Crump and E.F Jacob (Oxford at the Clarendon Press, 1969), pp 59-93. p. 63.
[4984] F. Braudel: *Grammaire*; op cit; p. 89.
[4985] Ibid.
[4986] Historia compostelana in Espana sagrada; ed. H. Florez; Madrid; 1791; XX; 133-4. in D. Metlitzki: *The Matter of Araby in Medieval England* (Yale University Press, 1977), p.124.
[4987] M.L. de Mas Latrie: *Traites de paix*; op cit; .p.7.
[4988] H. Wieruszowski: The Norman Kingdom of Sicily and the Crusades; in *Politics and culture in medieval Spain and Italy*; ed H. Wieruszowski; Edizioni di Storia e Letteratura (Roma; 1971), p. 26.
[4989] Ibid.
[4990] Ibid. p. 27.
[4991] Ibn al-Athir; 121; and An-Nuwayri: 185; in D. Abulafia: The Norman Kingdom of Africa and the Norman Expeditions to Majorca and the Muslim Mediterranean; in D.

westwards as far as Bejaia, another terminal of the trans-Saharan route, and possibly at this time a more prosperous centre than Al-Mehdia or Tripoli.[4992] The Norman aim was nothing less than permanent rule over North Africa.[4993] The results of such occupation were soon visible: Roger's conquests in North Africa effectively cut off the alternative non Sicilian route to traffic from east to west, Tunis being the only stopping point not under direct Norman dominion.[4994] The caravan routes from Morocco through Tunisia to Egypt were also policed and taxed by the Normans.[4995]

The Norman domination of the region was ended by the Almohads in the 1150s. The Almohad troops moving ever eastwards were helped by a series of well engineered Muslim uprisings against the Normans, and North Africa was once more brought under Islamic rule.[4996]

However, the Almohad success failed to put a stop to the pirate raids on the Muslim coast. In 1157 a Norman fleet appeared in the Muslim Balearic islands, at Ibiza, which was raided and devastated.[4997] These islands were wrested from the Muslims alongside the rest of the Muslim Spanish realm in the 13th century. This left North Africa a primary target for further and repeated Christian raids as in 1284 and 1285, when, taking advantage of the pretenders' fight for the throne in Tunis, Roger Doria, Admiral of Aragon landed suddenly on the island of Gerba and ravaged it, gathering immense booty, and taking more than 2000 captives, which he sold in Europe.[4998]

The same devastation was also inflicted further east, on Egypt. William I of Sicily, Roger's successor, in 1155 sent a fleet against Tinnis and other towns in the Nile Delta.[4999] His successor, William II, sent many fleets against Egypt in the 1170s. This followed Salah Eddin's (d. 1193) taking over the country after the Fatimid state had collapsed, and so William II worked hard to counteract the dangers a united Muslim world would

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Abulafia: *Italy, Sicily and the Mediterranean 1100-1400* (Variorum Reprints; London; 1987), pp. 27-49. p. 34-5.

[4992] Ibn Khaldun 202 for attacks on the coast of the state of Bougie in D. Abulafia: The Norman Kingdom of Africa. p. 36.

[4993] D. Abulafia: The Norman Kingdom of Africa. p. 47.

[4994] Ibid. p. 36.

[4995] Ibid.

[4996] M. Amari: *La Storia dei Musulmani di Sicilia,* 3 vols, (1933-9) Revised 2nd edition by C.A. Nallino, Rome; pp. 481-2.

[4997] Romuald of Salerno: 242 in D. Abulafia: The Norman Kingdom of Africa. Op cit; p. 42.

[4998] M.L. de Mas Latrie: *Traites de paix*. Op cit; p.157.

[4999] M. Amari: *La Storia;* op cit; pp. 477-8.

pose.[5000] In 1174, William sent a vast, magnificently equipped navy to Alexandria, conservative estimates putting the force at 30,000 men, intending to link up with the armies of Amaury I, King of Jerusalem.[5001] The expedition failed, and the expeditionary corps was annihilated by the Alexandrian population.[5002] This did not discourage William, who in 1175-6 sent another two expeditions to attack the commercial centre of Tinnis near the Nile delta.[5003]

Coinciding with these naval raids, on land, the crusader effort also concentrated upon Egypt now it had fallen under Sunni rule. In 1218, a crusade began to arrive on the Nile Delta, including Italians, Spaniards, Gascons, Germans, and French, with ships from Venice, Genoa, and Pisa.[5004] In July 1221, Pelagius, the Pope's legate, and his army advanced southwards into the Egyptian delta, but the season of the annual rise of the Nile had come, and the Egyptian population cut the dykes. Soon the Crusaders found themselves surrounded by swirling waters, about to drown.[5005] Sultan Al-Kamil rescued the Franks and provided them with food and other supplies on the sole condition that they peacefully evacuated the country.[5006] Decades afterwards, in 1248, the French King, Louis IX, better known as St Louis, launched yet another crusade. He captured Damietta in 1249, and then advanced on Cairo, reaching al-Mansurah, in March 1250, where he was crushed by the Mamluk army.[5007]

Throughout this medieval period, coinciding with the crusades, the Mediterranean remained a high risk area for Muslim shipping. Neither Muslim merchants, nor even pilgrims, could venture into the sea. Pilgrims preferred to travel overland all along the African coast, because this was entirely an Islamic road, and avoiding travel by the sea, for Western Christians had made the Mediterranean sea dangerous for Muslim craft to cross it lengthwise.[5008] The Mediterranean, once an Islamic lake, now sank any venture. An Arab poet, Braudel quotes, saying:

> 'Do not wonder to see my hair grow white from sorrow, but you must wonder why the black of my eyes had not become white

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[5000] D. Abulafia: The Norman Kingdom of Africa. op cit; p. 45.

[5001] H. Wieruszowski: The Norman Kingdom of Sicily. op cit; pp. 40-1.

[5002] Ibid.

[5003] Ibid. p. 41.

[5004] C.R. Conder: *The Latin Kingdom*; op cit. p. 310.

[5005] J. Glubb: *A Short History;* op cit; p.185.

[5006] Ibid.

[5007] G.W. Cox: *The Crusades*; op cit; p. 204.

[5008] G. Sarton: *Introduction;* op cit; p. 775.

instead. Now the sea belongs to the Roum. Boats that venture on it only do at great risk. Only the land belongs to the Muslims.'[5009]

These Christian attacks on Muslim coastal parts and shipping, according to Hillenbrand, citing Malouf, were the result of the crusades, and:

> 'After the Crusaders departed, the Muslim world turned in on itself, going on the defensive, feeling excluded and viewing modern technological developments as a manifestation of 'the other'.[5010] 'Modernism was synonymous with the West, whence had come the Crusades.. After the Crusades, the Muslim world which had defeated the Western Europeans faced the undeniable and bewildering truth that these same defeated enemies were enjoying genuine economic, technological and cultural growth and had gone on to rule the world.'[5011]

Thus, according to Hillenbrand and Malouf, like the majority of Western historians, the Islamic decline was due to Muslim hostility to trade following the crusades. Which is wholly false, and a ridiculous explanation that ignores historical evidence. It was not the Muslims, who from championing trade, suddenly hit by some sort of paralysing ineptness, became the enemies of trade, but rather the reverse. From precisely this time, following the crusades, until the colonial period, it became a central Western Christian policy, under the aegis and patronage of the Papacy, to destroy the Islamic economic system. It was in the late 13th century, that a Franciscan by the name of Fidenzio of Padua advised Pope Nicholas IV (1282-92) on the details of a project entitled: '*Liber Recuperationis Treer Sancte*,' which involved the maritime blockade of the Muslim land, and putting military bases in Armenia and Syria.[5012] Already, on the fall of Acre in 1291, Pope Nicolas IV decreed the banning of supplies to the sultan of all products of war, horses, iron, wood, foodstuffs, and other articles; excommunication threatened on whomsoever defied the ban; the guilty declared infame perpetually, deprived of all their civil rights, and unable to either act as witnesses or inherit.[5013] Then in the early decade of the 14th century, a propagandist, Marino Sanuldo the Elder (1274-c.1343), travelled widely in the Near East, and collected a mass of data on the region. His argument in '*Secreta*

[5009] F. Braudel: *Grammaire des Civilisations*; op cit; p.90.
[5010] A. Malouf: *The Crusades*; p. 264 in C. Hillenbrand: *The Crusades;* op cit; p. 612.
[5011] C. Hillenbrand: *The Crusades*, p.612.
[5012] A.S. Atiya: *Crusade, Commerce and Culture* (Oxford University Press; London; 1962), p. 95.
[5013] In W. Heyd: *Histoire;* part ii; op cit; p. 25.

Fidelium Crucis',[5014] of which the first edition was dedicated to Pope Clement V in 1309, was simple: if the sultan of Egypt was to be deprived of his chief source of revenue, which was trade, he would ultimately fall into a state of material and military bankruptcy, and so the crusaders could conquer the Holy Land without difficulty.[5015] To impoverish the Sultan, Sanuldo proposed a ban on trade with the Muslims and strict maritime blockade under papal leadership until the Egyptian economy was destroyed.[5016] At the same time, in 1307, a memo from the Grand Master of the Knight Templar went the same way advising the cessation of trade with the Muslims.[5017] The missionary, Raymond Lull, in 1306, had likewise advised that, if the Christians upheld buying spices from the Egyptians for just six years, and then set foot in Alexandria or in Syria, it would ruin the Sultan, rendering a crusades needless.[5018] The papacy also had knowledge of the history of the Orient written by the Armenian Prince, Hayton (Hethoun),[5019] who also recommended, as a preparatory measure, before any further crusades, stopping exports from Egypt, which would eventually lead to a state of total deprivation.[5020] In the late 13th-early 14th century, Manuel Zaccaria was charged by the Church authorities to form a fleet to police the Eastern coast, and in 1308, the Order of St John inherited this mission granted by Pope Clement V.[5021]

The onslaught on the Muslim sea trade and coastal towns intensified as soon as this policy was formulated. In 1303, a certain Marino Bulgaro, probably of Genoese origin, cruised the waters around Crete, and gave chase to every vessel which was aiming for Alexandria.[5022] In 1304, the Pisan fleet, reinforced by Genoese ships, and probably Provencal ships, took the city of Bone (Eastern Algeria), and ravaged the coast to Carthage.[5023] In 1308, Pope Clement V issued a new edict, forbidding exchanges with the East, and warned that any tradesman caught was straight delivered into slavery.[5024] Soon, ten cruisers were despatched to

[5014] Published by M. Kunstmann: Etudes sur Marino Sanuto l'ancient; see M. Heyd: *Histoire;* op cit.
[5015] A.S. Atiya: *Crusade;* op cit; p. 98.
[5016] Ibid. p. 99.
[5017] Baluze: *Vitae papar Avenion.*, II; p. 180 in W. Heyd: *Histoire*; op cit; p. 27.
[5018] In W. Heyd: *Histoire*; op cit; p. 27.
[5019] Historia orient., cap. 56; in M. Heyd: Op cit. 27.
[5020] In. W. Heyd: *Histoire;* pp. 27-8.
[5021] Raynald.a.a1308, no 34; Paoli, II, p. 19; 31, in W. Heyd: *Histoire*; op cit; p. 29.
[5022] Taf et Thom., ined., *commemoriali*; I; p. 40; No 176 in W. Heyd: *Histoire*; op cit; p. 30.
[5023] M.L. de Mas Latrie: *Traites de paix*; op cit; p.8.
[5024] W. Heyd: *Histoire;* op cit; p.27.

the waters, principally between Asia Minor and Egypt, to attack any merchant boat sailing the sea, and to pursue them down to the coast and the ports.[5025] Both Syrian and Egyptian coasts were devastated by repeated raids,[5026] especially the coastal towns of Beirut, Tripoli, Alexandria, Rosetta, Damietta. In the year 1363 there took place a succession of raids by the King of Cyprus, resulting in the burning of Tripoli, Tortosa, and Latakia.[5027] In the Autumn of 1365 a combined European fleet totalling 165 vessels departed for a secret target, the direction to Alexandria only cited at the last moment. On October 9, 1365, they landed, and for seven days they slaughtered, pillaged, and set the city on fire.[5028] The capture, loot and evacuation of Alexandria in 1365 was one of the most profitable as well as destructive sacks in history.[5029] Alexandria had long existed in uninterrupted peace and prosperity, the sack produced such immense booty, that considerable quantities were thrown at sea, and vast numbers of the population were enslaved, and still greater numbers massacred, Muslims, Copts and Jews alike.[5030] In the following years (Dec 1366, and Sep 1367), Egyptian and Syrian coastal towns suffered raids led by the fervent crusading monarch of Cyprus, Peter I.[5031]

The nascent Ottoman power was subjected to many attacks, too. A wide alliance of fleets and forces, from the early 1330s, were directed against Turkish positions in the Aegean.[5032] In 1334, following the preaching of a crusade the year before, a force consisting of papal, Venetian, French, Byzantine, Hospitaller and Cypriot ships defeated a Turkish navy, whilst the Hospitallers, Byzantines and Cypriots went on to attack the Turkish held port of Smyrna (Izmir).[5033] Ten years later, in 1344, in response to a crusade preached in 1343, a combined papal, Venetian, Hospitaller and Cypriot fleet succeeded in capturing Smyrna.[5034] These attacks reflected the awareness that for both military and commercial purposes the Turks, and in particular Turkish naval power had to be kept in check.[5035]

[5025] Ibid. p.28.
[5026] I.M. Lapidus: *Muslim Cities;* op cit; p. 27.
[5027] C.R. Conder: *The Latin Kingdom;* op cit; p. 417.
[5028] A.S. Atiya: *Crusades*; op cit; p. 103-4.
[5029] N. Daniel: *The Arabs*; op cit; p.308.
[5030] Ibid.
[5031] Machairas; p. 102 and sub; Machaut; p. 205; in W, Heyd: *Histoire*; op cit; pp 55-6.
[5032] P.E. Edbury: The Crusading Policy of King Peter I of Cyprus, 1359-1369; in *The Eastern Mediterranean Lands in the Period of the Crusades*; P. M. Hold Editor (Aris and Phillips Ltd; Warminster; 1977), pp. 90-105. at p.91.
[5033] P. Lemerle: *l'Emirat d'Aydin, Byzance et l'Occident (*Paris, 1957), pp. 90-100.
[5034] P.E. Edbury: The Crusading Policy; op cit; p.91.
[5035] Ibid.

A similar picture emerges in the western Mediterranean, that is on the North African coast, where the Christian aims of conquest were combined with corsair activity. Thousands of peasants and land owners of all conditions were kidnapped in Gerba in 1310, and Tripoli in 1355, by Muntaner, Roger and Philipe Doria, and then resold in Europe like 'vile livestock.'[5036] Between June and September 1390 there took place a major expedition against El-Mehdia.[5037] It was an alliance of principally Genoese and French, and was blessed by Pope Clement VII (Pope 1378-1394), and officially declared a crusade.[5038] 'Gentlemen' from France, England, Hainault and Flanders swelled the numbers. The unexpected armed response from Tunis, Bejaia, and Tlemcen foiled the project after a strained campaign.[5039] A treaty was reached for Christian withdrawal on condition that the King of Tunis paid a tribute over fifteen years, and an immediate indemnity of 25,000 ducats.[5040] This treaty was one amongst the countless the Muslims were forced to agree to save their land from pirate attacks. This did not restrain such attacks. Iberian corsairs, for instance, saw no reason to abide by treaties signed between the Muslims and the Sicilians, the Portuguese arguing a continuous state of war with Tunis to justify their actions.[5041] The Portuguese kept up the *Guerra do corso*, or incessant corsair activity in the Mediterranean;[5042] and in both Mediterranean and Atlantic, they were imitated by both the Spanish and French.[5043] The Catalans, for their part, attacked Muslim principalities, including those under Norman Sicilian protection, as in 1307, when they ravaged Gerba and Pantelleria.[5044] Any incident with either Tunisian custom officials or Bedouin tribal leaders was an excuse to resume attacks against Muslim shipping.[5045] Terrible cruelties were inflicted on the Muslims in the process, 'reminiscent of a crusader spirit; and even the

[5036] M.L. de Mas Latrie: *Traites de paix,* op cit; .237.
[5037] Froissart (1338?-1410?) *Chronicles*, Liv. IV, chap. xiii, fol. 55 and following.
[5038] A.S. Atiya: *Crusade,* op cit; pp. 105-6.
[5039] Ibid.
[5040] Ibid.
[5041] Aca Cancileria 2833, f, 155 in H. Bresc: La Course Mediterraneene au Mirroir Sicilien (XII-XVem Siecle); in *Politique et Societe en Sicile; XII-Xv em siecle* (Variorum; Aldershot; 1990), pp. 91-110; p. 97.
[5042] S. Subrahmanyam: *The Portuguese Empire in Asia 1500-1700* (Longman; London; 1993), p. 38.
[5043] Ibid. p. 49.
[5044] Nicolaus de Sancta Oliva, de Valence, et Sarrer de Tarragone; ACA (Arxtiu de la Corona de Arago, Barcelona) Letras reales Jaime II 10 226 in H. Bresc: La Course Mediterraneene; op cit; p.93.
[5045] ASP (Archive di Stato Palermo); ND. A.Aprea 813, 3.06. 1457 in H. Bresc: La Course Mediterraneene; op cit; p. 97.

Jews, confounded with Muslims, suffered considerably as a result of the hate for Muslims,' notes Bresc.[5046] The Tunisian Hafsid state, too weak, fell prey to invaders infesting its coastline, and crippling its maritime activity.[5047] Morocco, likewise, faced the combined alliance of Castilian and Portuguese who defeated the ruling Merinids in 1340 at Salado,[5048] whilst a Castilian-Genoese alliance in 1344 destroyed its navy.[5049] Loot and mass enslavement devastated the coastal economies of the Maghrib for centuries until, in alliance with the Turks, the Maghrebi formed a powerful alliance to fight back.[5050]

Until such an alliance, Muslim principalities earnestly pursued a policy of payment of tribute to their Christian neighbours in exchange for protection. The tribute paid by the kingdom of Tunis to Sicily to safeguard its subjects from attacks by Sicilian Pirates,[5051] amounted to 34,333 golden besants.[5052] Muslim princes had to pay exorbitant indemnities to the Venetians even for ill deeds caused by other Christians on the Venetians.[5053] The archives of the Bank of St Georges in the 15th century reveal that the Genoese obtained an undertaking from the Tunisian rulers in 1456, that they put no blame on the Corsicans for the deeds of their pirates, expecting that the treaties existing between the Republic and the King of Tunis had to protect the Corsicans like the other Genoese subjects.[5054] Payments were also made to the Iberian powers, the treaty with Bejaia of 1314, for instance, agreeing a payment to the king of Aragon of 500 ducats a year from the yield of the '*robes e mercaderies que pagaren dret en la duana de Bugia*'.[5055] The treaties of 1314 and 1323 with Tunis allotted to the king 4000 ducats a year out of the dues paid by his subjects.[5056]

Christian aims for North Africa, however, went further than naval onslaught and loot, and receiving payment for protection was just temporary expedient. As Armesto notes, it was normal for medieval

[5046] ACA Cancilleria 2824, f. 64 v in H. Bresc: La Course Mediterraneene at p. 97.
[5047] H. Bresc: La Course Mediterraneene; op cit; p. 94.
[5048] S. Subrahmanyam: *The Portuguese Empire*; op cit; p. 38.
[5049] J.A. Robson: The Catalan fleet and Moorish sea power; *The English Historical Review*; Vol LXXIV: (1959): pp 386-408; p.407.
[5050] H. Bresc: La Course Mediterraneene; op cit; p. 102.
[5051] Gregorio: Considerazioni, Vol ii, p. 245. in M.L. de Mas Latrie: *Traites de paix*.p.52.
[5052] M.L. de Mas Latrie: *Traites de paix*.p.52.
[5053] Ibid.p.171.
[5054] Ibid. p.xii.
[5055] F. Fernandez Armesto: *Before Columbus* (MaCMillan Education; London, 1987), p.133.
[5056] Ibid.

Hispanic Christian states 'to mulct Moorish neighbours for protection money,' and frequently this tributary relationship was a prelude to conquest.[5057] The rights of legitimate 're-conquest' (re-conquista) which Hispanic Christian kings claimed over the Muslims were universally assumed to extend into North Africa.[5058] This policy is expressed in Arnau of Vilanova's *De Mysterio Cymbalorum*, written no later than 1301, and refined into a programme which included the conquest of Africa.[5059] Years before, in 1282, as soon as Spain was taken from the Muslims, Pedro III launched a vast armada against Collo (Alcoll) (east Algeria), thus showing the strength of Aragon's feeling about the Maghrib.[5060] The chronicle of 'Bernat Desclot' was written probably within a few years of the event by a royal household official who helped to prepare the expedition. His account can be taken to represent the 'official' Aragon version:

> 'The king's desire to seize Constantine and subdue all Africa was genuine, and espoused for the honour of God and the sake of all Christendom. If the pope lent him aid, he would stay in Africa, and his barons professed themselves ready to send for their wives and children.'[5061]

In 1284-86 the Tunisian islands of Gerba and Qarqannah (Kerkennah) were added to the Aragon dominions; the islands were suitably qualified to count as Europe's first African colonial possession.[5062] Decades after, in the course of the 14th century, the rulers of Portugal sought papal bulls of crusade on at least five occasions in pursuit of plans to conquer Morocco.[5063]

The Iberian project for the conquest of North Africa, with papal blessing, took great impetus in the 15th century.[5064] In 1400, Henry III, King of Castile, landed a fleet in Tetuan (Morocco), and a large majority of the population was taken into slavery.[5065] In 1415, the Portuguese with an army of over 50,000 men and a navy in excess of 230 vessels took Ceuta.[5066] In 1458, they advanced on Ksar-el-Srir (Ksar al-Sghir), and towards Tangiers, but despite Spanish assistance, failed to take

[5057] Ibid.
[5058] Ibid.
[5059] Ibid. p.130.
[5060] Ibid.
[5061] Ibid. p.131.
[5062] Ibid.
[5063] S. Subrahmanyam: *The Portuguese Empire;* op cit; p. 38.
[5064] F. Fernandez Armesto: *Before Columbus*; op cit; p.148.
[5065] E. Cat: *Petite Hitoire de l'Algerie, Tunisie et Maroc;* Vol 1 (Algiers; A. Jourdan; 1889), p. 225.
[5066] Ibid.

Tangiers.[5067] In 1471, Tangiers capitulated to them.[5068] Early in the 16th century, during Don Manuel's reign, new fortified settlements were created at Agadir (1504), Safi (1508), and Azemmour (1513), the purposes of which was to deny the rulers of Morocco access to the seashore and the sugar export trade of Agadir and Azemmour.[5069] These conquests were seen one of the prongs of a proposed attack on Jerusalem, in pursuit of which the Portuguese tried and failed to take Mers al-Kebir (Algeria) in 1501.[5070]

Under papal patronage, Spain and Portugal reached agreement at Tordesillas (in 1494) to share task and spoils in Muslim North Africa.[5071] After taking Melila in 1497, the Spaniards took Mers el-Kebir in 1505. In 1509, Pedro Navarro led an expeditionary force of 10 galleys and 80 ships, 8000 foot and 3000 horses against Oran, described as 'the principal port of the trade of the Levant.'[5072] Cardinal Ximenes himself and ship-owners financed the enterprise. The city was captured, 4000 inhabitants slaughtered, and 5,000 carried to Spain together with booty valued at half million gold ducats.[5073] The year after, Bejaia and Tripoli fell to the Spaniards, and Algiers came under threat. The conquest of the whole of North Africa was now a mere matter of time, except for the unexpected arrival on the scene of the so-called Barbarossa brothers.[5074]

It was at Gerba, that the Portuguese-Spanish facile conquest was brought to a disastrous end by the Barbarossa brothers: Arooj and Khair Eddin.[5075] The Spaniards had failed to realise that for some years, already, the island had been occupied by the Turks. Arooj, the Turkish leader had been invited by the Tunisian rulers to protect them against the Spaniards.[5076] Soon the same invitation came from the Sheikhs of Algeria for the Turks to intervene, the Turks 'being the most formidable nation of the period, and the most warlike people of that time.'[5077] In 1516, the elder brother, Arooj, recaptured Algiers from the Spaniards,[5078] which was followed by the retaking of Bejaia, Tripoli and other places by other Turkish seamen in

[5067] Ibid.
[5068] M.L. de Mas Latrie: *Traites de Paix*; op cit; p.324.
[5069] S. Subrahmanyam: *The Portuguese*; op cit; p. 85-6.
[5070] Ibid.
[5071] E. Cat: *Petite Histoire*; op cit; pp. 226-7.
[5072] In G. Fisher: *Barbary Legend* (Oxford at the Clarendon; 1957), p. 34.
[5073] Ibid.
[5074] J. Glubb: *A Short History of the Arab Peoples;* op cit; p.262.
[5075] G. Fisher: *Barbary*; op cit; p. 36.
[5076] Ibid.
[5077] Ibid.
[5078] J. Glubb: *A Short History of the Arab Peoples*; op cit; p.262.

the ensuing decades. Soon, the Mediterranean became the theatre of naval conflict between the Turkish and mainly Algerian fleet on one side, and Christian fleets, on the other, battling for the next century and a half.[5079]

Coinciding with this North African-Turkish allied fight back arose the myth of Muslim Barbary Piracy ruining Western Christian trade and inflicting all sorts of cruelties upon Christians.

b. The Myth of Barbary Corsairs, and the Effects of Piracy on North Africa from the 16th to the 19th Centuries:

The Myth of the Barbary Corsairs (16th-19th centuries) although thoroughly demolished by Earle,[5080] Fisher,[5081] and Bono,[5082] who all focused on the issue, still finds its defenders amongst most scholarship, some such as Chaudhuri, ardent defenders, indeed. Chaudhuri speaks of:

> 'North African Muslim corsairs ravaging coastal areas as far apart as Cornwall and Sicily.'[5083]

Brockelmann, for his part, writes:

> 'Down to the beginning of the 19th century the Beys of Tunisia an the Deys of Algiers, as well as the Qaramanlis in Tripolitania and the rulers of Morocco, had diligently pursued a career of piracy, which being directed against the Christians, was regarded by the Muslims as a meritorious war of faith. The Christian states had never been able to unite in a common action against them.'[5084]

However, this generalised interpretation of history is fallacious. Far from being a den of pirates, Algiers was a recognised port of call for English shipping in the 16th century; and so was Tunis, a port of call for Christian shipping.[5085] No less remarkable, Fisher points out, was the competition for permanent commercial concessions in those areas.[5086] If there was

[5079] A.R. Lewis ed: *The Islamic World and the West* (John Wiley and Sons; London; 1970), Epilogue.
[5080] P. Earle: *Corsairs of Malta and Barbary* (Sidgwick and Jackson; London; 1970), as at pp 38-40.
[5081] G. Fisher: *Barbary*; op cit.
[5082] S. Bono: *I Corsari Barbareschi* (Torino; 1964).
[5083] K.N. Chaudhuri: *Trade and Civilisation in the Indian Ocean* (Cambridge University Press; Cambridge; 1985), p. 78.
[5084] C. Brockelmann: *History of the Islamic Peoples;* op cit; p. 292; p. 397.
[5085] In G. Fisher: *Barbary Legend*; op cit; 123-4.
[5086] Ibid.

Barbary piracy, it came as a response to the piracy of which the Muslims were victims, and which had been going on for centuries.[5087] Muslim piracy was never as destructive and as cruel as the Christian, or as depicted in history. Barbary piracy, in fact, as demonstrated by Fisher, most particularly, was one of the greatest legends of modern history to justify the colonisation of Algeria, and that of the whole of North Africa.[5088] This was a pattern established long before, the Portuguese conquest of Ceuta in 1415, for instance, blamed on Muslim piracy, and similar justification used for Spanish attacks on Mers el-Kebir and Oran early in the following century.[5089] The French blaming Algerian piracy to justify the invasion of Algeria in 1830 rests on hardly any solid ground, though, for, when William Shaler, the new American ambassador arrived in Algiers, in 1815, he could see that all the Algerian fleet consisted of was four frigates, five corvettes, one brig, and a galley, a total of eleven vessels.[5090] These were to suffer final annihilation by Lord Exmouth famed bombardment of Algiers in 1816.[5091]

From the 16th century down to the colonial age, in the 19th century, during the so-called reign of the Barbary Pirates, rather than Muslim piracy impoverishing Western shipping, it was Muslim North Africa that was bankrupted by Christian piracy. Early in the 16th century warring Christian merchants descended upon the Atlantic coast of North Africa between the capture of Agadir (1505) and the fortification of Mazagran (1514) with devastating efficiency.[5092] Coastal fortifications helped Western powers to lock Morocco and secure the oceanic routes leading to India and beyond.[5093] On land, the overwhelming Portuguese military superiority threw back Muslim warriors and permitted Christian merchants to tap the economic resources of Morocco's rich plains.[5094] Gradually, Muslim coastlines became zones of greater insecurity, too.[5095] Corsairs armed by the Knights of Malta,[5096] or flying the flag of the Two Sicilies, harassed

[5087] A. Mieli: *La Science Arabe*; op cit; p. 45.
[5088] G. Fisher: Barbary legend; op cit; L. Valensi: *North Africa;* op cit;
[5089] G. Fisher: *Barbary Legend*; p. 24.
[5090] A. Hollingsworth Miller: One man's View: William Shaler and Algiers; in *Through Foreign Eyes;* ed by A.A. Heggoy (University Press of America; 1982), pp. 7-55; at p. 18.
[5091] C. Lloyd: *English Corsairs on the Barbary Coast* (Collins; London; 1981), pp. 163-4.
[5092] A C. Hess: *The Forgotten Frontier* (The University of Chicago Press, 1978), p.34.
[5093] Ibid.
[5094] See *Chronique de Santa Cruz du Cap de Gue*; tr. P. De Cenival (Paris; 1934), pp 20-159.
[5095] J. Mathiex: Trafic et prix de l'Homme en Mediterranee au 17 et 18 Siecles; *ANNALES: Economies, Societes, Civilisations*: Vol 9: pp. 157-64; pp.163-4.
[5096] See E.W. Shermerhorn: *Malta of the Knights* (London; 1929).

North African commerce and maintained a state of insecurity until the 18th century.[5097] The Knights of Malta, who had been operating before from Rhodes until 1523 when the Ottomans dislodged them, found refuge in Malta and terrorised Muslim shipping, seizing hundreds of Muslim merchant ships through the 16th, 17th and down to the 18th century (204 ships in 1764 alone).[5098] By the summer of 1600 no quarter of the Mediterranean remained safe from the violence of pirates from the British Isles either, 'For this accursed race is grown so bold that it goes everywhere without hesitation, using barbarous cruelty, and sinking ships,' said a Venetian ambassador.[5099] Attacks also multiplied against the North African coast, English and Tuscan Knights of St. Stephen burning Bona (in eastern Algeria), slaying hundreds, and carrying immense booty, including 1500 captives.[5100] In 1663, it was the French navy that launched a major attack on the eastern Algerian port of Jijel, before Bejaia another city port nearby, was attacked in May 1671.[5101] Such attacks on North African sea ports, Algerian above all, went on until the French occupation of Algeria in 1830.

Behind such attacks, the aim, Valensi notes, was to prevent the formation of any Muslim merchant shipping, blocking efforts to create Muslim commercial fleets or successful trade.[5102] Earle explains how the Christian corsairs' aim was precisely to break Muslim merchant shipping, whilst at the same time Muslim corsairs could not attack English or French ships because of treaties passed with both 'Barbary' (Algeria, Tunisia and Libya) and Turkey.[5103] As they agreed treaties with Muslim governments, the French financed the Knights of Malta to destroy their navies.[5104]
In an effort to escape ravages caused by pirates, Mathiex explains, Muslim traders used foreign shipping so as to obtain protection for themselves if taken by pirates. European pirates found ways round this, too, citing that Pavilions only covered merchandise.[5105] Being seized on the high seas as a Muslim led straight to enslavement and the galleys for

[5097] L. Valensi: *North Africa;* op cit; p. 47; and note 1; p. 54-5.
[5098] Ibid.
[5099] Venetian Ambassador to Spain: Calendar of State Papers, Venetian (1592-1603); pp 412-3. in K.R. Andrews: Sir Robert Cecil and Mediterranean Plunder; in *The English Historical Review*; Vol 87 (1972); pp 513-32; at p. 514.
[5100] G. Fisher: *Barbary*; op cit; p. 153.
[5101] Ibid. p. 237; pp 243-4..
[5102] L. Valensi: *North Africa*; op cit; p. 47.
[5103] P. Earle: *Corsairs of Malta and Barbary*; op cit; pp 38-40.
[5104] Ibid. p. 97 ff..
[5105] J. Mathiex: Trafic et prix de l'Homme en Mediterranee; op cit; p.159.

perpetuity.[5106] The galleys were much more numerous on the Christian side because of the much superior navy, and the much greater needs were met by ever increased raids against Muslims.[5107] Livourne (a slave port) thrived as a result of attacks on Muslim shipping; each slave trader at the end of the 17th century possessing two or three houses specialising in the trade; the poorest amongst them with a capital of 150,000 ecus.[5108] So lucrative a trade was this, that it attracted some of the leading figures of Western nations such as Sir Robert Cecil, who on 12 January 1603 informed Sir Walter Raleigh of his intention to invest in a certain privateer, inviting him and Lord Cobham to take shares in the venture.[5109] The galleys were one woe, but worse could be also experienced, as by the Algerian trade mission to Marseilles in 1620, which was massacred by a local mob.[5110] Valensi insists that the destruction of Muslim trade was to eliminate Muslim competition.[5111] In 1790, the French Charge d'Affaires in Malta declared:

> 'The continued prosperity of Marseille's trade, which provides the Order with substantial tokens of concern for it, requires that we attempt to keep the Turks from carrying their merchandise on their own vessels, thus keeping them dependent on us.'[5112]

Tradesmen from North Africa, whether Muslims or Jews, were looked at askance north of the Mediterranean, where the intent has remained to prevent the creation of a Muslim merchant fleet, and both Muslims and Jews suffered constant harassment on arrival on the European side[5113] (that is if they escaped the corsairs on the high seas).
Summing up, Mathiex notes that the Maghrebi and Turkish economies were bled just at the time when North Africa and the Levant were awakening to the great sea trade.[5114] Islamic sea trade ventures dying as soon as they were born.[5115]

The same fate, under the same circumstances, was experienced East, on the Indian Ocean.

[5106] Ibid. p.161. Note 3.
[5107] G. Fisher: *Barbary*; op cit; p. 163.
[5108] Consul Cotolendy (Livourne) letter to Ministre Maurepas, 14 Febr, 1682; (*Arch. nat.* A.E.B.1, 697).
[5109] K.R. Andrews: Sir Robert Cecil and Mediterranean plunder; op cit; at p.513.
[5110] G. Fisher: *Barbary*; op cit; p. 185.
[5111] L. Valensi: *North Africa*; op cit; p.48.
[5112] In J. Mathiex: Sur La marine marchande barbaresque, in *Annales, ESC*, 1958; p. 90.
[5113] L. Valensi: *North Africa*; op cit; pp. 58-9.
[5114] J. Mathiex: Trafic; op cit; pp.163.
[5115] Ibid. pp.163-4.

c. The Destruction of the Muslim Indian Ocean Trade:

In the East, Abu Lughod explains, a complex system of trade dating from the 9th century passed through the geographic heartland of the system, the land bridge of the eastern Mediterranean that guarded three route access to the Orient: a northern route from Constantinople across the land mass of Central Asia; a central route connecting the Mediterranean with the Indian Ocean via Baghdad, Basra, and the Persian Gulf, and the third, southerly route, that linked the Alexandria-Cairo-Red Sea complex with the Arabian sea and then the Indian Ocean.[5116] Whether in war or peace, such routes brought distant trading partners in contact with one another.[5117] The 13-14th centuries were a period of intensive trade and free traffic in the Indian Ocean, and there were Arabs in China, Chinese in the Persian Gulf, and Indians in all parts of the Ocean.[5118] Muslim merchants traded freely with all parts of India and in China,[5119] and unlike the Atlantic and Pacific oceans, the Indian Ocean, in fact, served as a bridge spanning the different cultures bordering on it, not as a barrier separating them.[5120] The Indian Ocean constituted an ecumene, where Arabs, Persians, Indians, and other south Asian people came into contact, both materially and culturally.[5121] No attempt was made to control mercantile activity, Muslim, Hindu and Chinese merchants competing freely for the spice trade of India and Indonesia.[5122]
The Portuguese intrusion into the region beginning in 1498 changed all this. It not only destroyed the free economic links between diverse nations, but it also annihilated the last bastion of Islamic prosperity.

Nevertheless, the Portuguese intrusion has its apologists. Longworth Dames, for instance, holds:

> 'It is generally taken for granted that the Eastern trade once the route by the Cape of Good Hope had been made known, fell of itself, and as it were automatically, into the hands of the bold adventurers who were the first whoever burst into the Indian Ocean.... and that the wealth of the Indies thenceforward flowed

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[5116] J. L. Abu-Lughod: *Before European Hegemony*, op cit; p.137.
[5117] Ibid.
[5118] S. Arenson: Ships and shipbuilding; Red Sea and Persian Gulf; in *Dictionary of the Middle Ages*; op cit; vol 11; pp. 245-51; p.247.
[5119] J. L. Abu-Lughod: *Before European Hegemony*; op cit; p. 274.
[5120] S. Arenson: Ships and shipbuilding; p.250.
[5121] Ibid.
[5122] D. M. Traboulay: *Columbus and Las Casas*; op cit; p.71

in a smooth and uninterrupted stream to Portugal and to all Europe.'[5123]

Watt also says:

> 'The Portuguese on reaching India, were followed by the British, the French, and the Dutch, but for no conquest or settlement purpose. Their interest was just of trade as they wanted to get to the sources of supply of the spices, luxuries and goods coming to Europe through the Muslim lands of the eastern Mediterranean; but had to fight when there was armed opposition to their traders.'[5124]

This is the view shared by nearly all Western or Western based scholarship, a view, however, far from the truth.

Contrary to such historical writing, the Muslims were not at first hostile in any way to the idea of trading with the Portuguese as Velho clearly shows.[5125] One Muslim trader told the Portuguese:

> 'You should give many thanks to God for having brought you to a land where there are such riches.'[5126]

And, indeed, what the Portuguese saw at Calicut on arrival was staggering; a port where the shipping traffic reached between 500 and 700 ships. The city's markets were gorged with the richest abundance, or the rarest products; pearls, spices, precious metals, which all had the most profound effects on the Portuguese.[5127]

The Portuguese, however, had come to the East with the same aims as those they had towards North Africa: a crusading mission,[5128] and the same ardent desire to destroy Muslim trade.[5129] It is commonplace in writings on the subject, which speak of the 'Crusading spirit' of the Lusitanians.[5130] The greatest contemporary ideologue of the Portuguese expansion, the chronicler Joao de Barros, charged by his sovereign to

[5123] M. Longworth Dames: The Portuguese and Turks in the Indian Ocean in the sixteenth century*: Journal of The Royal Asiatic Society (JRAS);* Vol year 1921 pp 1-28; p.2.
[5124] W. M. Watt: *Muslim-Christian Encounters* (Routledge, London, 1991), p.91.
[5125] A. Velho: *Roteiro da primeira Viagem de Vasco de Gama;* ed Neves Aguas (Lisbon; 1987), as at pp.54-5.
[5126] S. Subrahmanyam: *The Portuguese Empire*; op cit; p.59.
[5127] W. Heyd: *Histoire*; op cit; pp. 510-11.
[5128] A. Villiers: *Monsoon Seas*; *The Story of the Indian Ocean* (Mc Graw Hill; New York), 3rd Edition; 1952; p.167.
[5129] L. F: Thomaz: Factions, Interests and Messianism. The Politics of Portuguese expansion in the East; 1500-21; *The Indian Economic and Social History Review*; xxviii; 1991; 1.
[5130] S. Subrahmanyam: *The Portuguese Empire*; op cit; p. 49.

write 'of the deeds that the Portuguese did in the discovery and conquest of the seas and lands of the Orient, began:

> 'There having risen in the land of Arabia that great Anti-Christ Muhammad, more or less in the year 593 of our Redemption, he so worked the fury of his steel, and the fire of his infernal sect by means of his captains and caliphs, that in the space of a hundred years, they had conquered all of Arabia, part of Syria, and Persia, in Asia, and in Africa all of Egypt beyond and before the Nile.'[5131]

It is thus the rise of Islam that, in Barros' view, provides the logical starting point for an understanding of how the Portuguese came to be in Asia.[5132] The plan for the Portuguese ruler, Dom Manuel, was to mount a two prolonged attack on the Mamluk kingdom of Egypt (or the Sultanate of Babylonia as his messianic supporters termed it), with one force attacking via North Africa, and the other via the Red Sea.[5133] The Red Sea strategy was to kill two birds with one stone: a blockade of the entry of the Red Sea would not only give the Portuguese a decisive advantage in the European market for pepper and spices over their Venetian rivals (who were supplied through Cairo and Alexandria), but also cut the revenues of the Mamluk state.[5134] Thus, following upon da Gama's second expedition of 1502, decision was taken to block the Red Sea to Muslim shipping.[5135] Destroying Muslim shipping in the East was also a clear an aim to Albuquerque, who, to his men insisted on:

> 'The great service which we shall perform to our Lord in casting the Moors out of this country and of quenching the fire of the sect of Mahomet so that it may never burst out again hereafter.'[5136]

After service to God, he alluded to the service to his king 'for,' he said:

> 'I hold it certain that if we take this trade of Malacca away from them, Cairo and Mecca will entirely be ruined.'[5137]

En route to ruining the Islamic eastern trade, the Portuguese massacred Muslims on the high seas and in coastal towns.[5138] Meeting with a vessel containing two hundred and sixty pilgrims bound for Makkah, of whom fifty were women and children, the Portuguese saved and baptised twenty

[5131] J. De Barros: *Da Asia;* Decadas I-IV; Lisbon; livraria Sam Carlos; facsimile of the 1777-78; Regia Oficina Tipografica edition; 1973; i/1: pp. 1-2.
[5132] S. Subrahmanyam: *The Portuguese Empire*; op cit; p. 49.
[5133] Ibid; pp.50-1.
[5134] L. F: Thomaz: Factions, Interests and Messianism; op cit.
[5135] R.B. Serjeant: *The Portuguese off the South Arabian Coast* (Oxford; 1963), p. 15.
[5136] In K.M. Panikkar: *Asia and Western Domination* (George Allen and Unwin Ltd; London; 1953), p. 49.
[5137] Ibid.
[5138] N. Daniel: *The Cultural*, op cit: p.138.

of the children; the remainder were thrust down into the hold, and the ship scuttled and set on fire.[5139] In 1500, Vasco De Gama, a 'Knight of Christ,' bombarded Calicut for three days, before embarking on cutting off ears, noses and hands of prisoners and then setting them alight. De Gamma also had boats of pilgrims on their way to Makkah sunk, and survivors speared in the water.[5140] In the following years, 1502-3, an Arab chronicler records:

> 'In this year (Rajab) the vessels of the Franks appeared at sea en route for India, Hormuz and those parts. They took about seven vessels, killing those on board, and making some prisoner. This was their first action, may God curse them.'[5141]

Corsair activity, practised in the Mediterranean and the Atlantic, now spread to the Indian Ocean.[5142] The Portuguese crown was heavily involved in sharing the corsair loot. According to the 1505 *Regimento*, the king took 20%, the treasury: 53.3%; and of the remaining 26.6%, the Viceroy retains 25%, and the captains, pilots, and soldiers sharing the rest in decreasing shares; a division which applied to both royal ships and those privately owned.[5143]

It is impossible to count the number of Muslim boats attacked, whether on the high seas, or close to the coastline: sunk; burnt after everything had been looted, and their passengers and crew all slaughtered.[5144] Muslim merchant ships could still venture in the Red Sea, but as soon as they entered the Indian Ocean, they were destroyed.[5145] They could hardly find refuge in India as the Portuguese fleet controlled the coastal area.[5146] So hunted was Arab shipping,' Serjeant explains, 'that even the coastal craft had to steal from creek to creek.'[5147] The Portuguese, and soon the Dutch, gradually swept the seas clear of organised Muslim fleets and diverted

[5139] For the cruelties of the Portuguese see Crawfurd (Indian Archipelago) II; 403, and for the Dutch, see especially II.425 seq. and 441. in R.B. Smith: *Mohammad;* op cit; p. 34.
[5140] A.Zahoor: Muslims in the Indian sub-continent; at: http://www.minhaj-audio.net/Astro/A%20Chronology%20of%20Muslims%20in%20the%20Indian%20Subcontinent%20-%20IV%20(1700-1800%20CE).htm
[5141] R.B. Serjeant: *The Portuguese off the South Arabian Coast;* op cit; p.43.
[5142] S. Subrahmanyam: *The Portuguese Empire*; op cit; p. 61.
[5143] Ibid; p. 52.
[5144] W. Heyd: *Histoire;* op cit; vol 2; p 535.
[5145] Ibid; p. 550.
[5146] Ibid.
[5147] R.B. Serjeant: *The Portuguese*; op cit; p. 14.

local commerce and long distance traffic alike into European vessels.[5148] An exultant Portuguese contemporary wrote:

> 'Mohammed is cornered and cannot go further and flees as much as he can... and the truth is that Mohammed will be destroyed and destroyed he cannot help but be.'[5149]

The effects on Muslim trade were indeed devastating. Alexandria used to handle between 1060 and 1200 tons of spices alone, in the years 1498-98; by 1501-1506, the average fell to 335 tons.[5150] Beirut used to handle between 1496-98 an average of 270 to 420 tons, by 1501-1506, this has fallen to just 45 tons.[5151]

By 1511, the Portuguese were already established with their own fortified trading posts at Hormuz, Goa, and Malacca, at the straits leading into the South China Sea.[5152] By controlling Hormuz, the Portuguese controlled the Gulf for, up to 1515, products from India went up through the gulf to reach southern Iraq, and then were carried up to Syria, where the Venetians used to buy them from the markets of Damascus, Aleppo, Tripoli, and Beirut, a traffic under exclusive Muslim control.[5153] Now Hormuz was blocked, Muslim trade was crippled.[5154]

To make matters worse, Muslim coastal towns were devastated. Albuquerque destroyed Kameran in 1513, killing all its population, before levelling it to the ground, so that 'the Moors of Jedda should not build defences there to prevent future Portuguese fleets from landing.'[5155] Many coastal towns of Hadramuwt suffered the same fate, the Portuguese ravaging the coastline, destroying ships, enslaving populations, and selling them on the African coast.[5156] Any ship sailing in the coastal proximity was set upon. Ships carrying merchandise were attacked or pillaged outside Qish., Qysay'ir, Mishaqs and al-Hami.[5157] Albuquerque,

[5148] A. R. Lewis: *The Islamic World*; op cit; .Epilogue.
[5149] In P. Coles: *The Ottoman Impact on Europe* (Thames and Hudson; London; 1968), at p. 107.
[5150] C.H.H. Wake: The Volume of European Spice Imports at the beginning and end of the fifteenth century; *Journal of European Economic History*; xv (1986); 3; p. 633.
[5151] Ibid.
[5152] M. Hodgson: *The Venture of Islam* (The University of Chicago Press; Chicago; 1974), vol 3; p. 21.
[5153] W. Heyd: *Histoire;* op cit; p. 549.
[5154] Ibid.
[5155] E. Denison Ross: The Portuguese in India and Arabia between 1507-1517: *Journal of The Royal Asiatic Society (JRAS)*; Vol year 1921 pp 545-562; at p.558; p. 556.
[5156] J. Chelhod: Les Portugais au Yemen d'Apres les Sources Arabes; *Journal Asiatique*, vol 283 (1995) pp. 1-18; pp. 10-11.
[5157] Ibid.

on his own, it is held, practically destroyed the Muslim power in the East during his governorship.[5158] Such was the devastation, Calicut, once the home of 15,000 Muslim merchants, became, in the 18th century, as an English visitor saw, a modest fishing village of low leaf thatched huts, in which remnants of Indianised Muslim merchants continued to exploit a dying trade.[5159]

The last bastion of Islamic trade was now in ruins, and the principal victim was the Mamluk state, which acted as a link between the East and West. The Mamluk sultan Qansawh al-Ghawri (1500-16) first initiated a series of diplomatic moves by means of the Venetian connections to have the papacy restrain the Portuguese.[5160] When this failed, a fleet was assembled, and engaged battle with the Portuguese, registering a great victory in 1507. Two years later, this same fleet was destroyed by the Portuguese at Diu.[5161] The Ottomans sought to resolve the problem, and engaged in a fierce campaign against the Portuguese. Ottoman efforts were, however, thwarted by local Muslim allies of the Portuguese, most particularly Shah Ismail.[5162] Another Shah, Bahadur, granted in 1535 the Portuguese the Island of Diu, from which they now operated.[5163]

The Portuguese eventually ruined the Mamluk state in its futile expenses for the protection of the fleet.[5164] To build a strong navy, the Mamluks required timber more than any item. However, the scarcity of wooded areas, generalised to the Muslim world, is much worse in Egypt; and without wood, there were no ships.[5165] Wood came from Syria, and Asia Minor principally;[5166] and Christian fleets made sure these imports never reached their destination. Attacks on ships aimed for Egypt were relentless, and pirates constantly seized shipments to Egypt of timber, iron, naval stores, and cannon.[5167] In August 1510, a fleet of the Knights of Rhodes pursued an Egyptian convoy down to Iskanderoun, and there

[5158] A. Cortesao: *Nautical Science and the Renaissance* (Coimbra; 1974), p. 14.
[5159] A. Das Gupta: *Malabar in Asian Trade; 1740-1800* (Cambridge University Press; 1967), p.1.
[5160] S. Subrahmanyam: *The Portuguese Empire*; op cit; p.66.
[5161] Ibid; p. 67.
[5162] P. Brummett: The Myth of Shah Ismail Safavi: Political Rhetoric and 'Divine' Kingship; in J. V. Tolan: *Medieval*; op cit pp 331-359.
[5163] M. Longworth Dames: The Portuguese and Turks; op cit; p.16.
[5164] I.M. Lapidus: *Muslim Cities*; op cit; p. 42.
[5165] B. Rosenberger: La Pratique du Commerce; in *Etats, Societes et Culture*; op cit; pp. 245-73; p. 254.
[5166] Ibid.
[5167] I.M. Lapidus: *Muslim Cities*; op cit; p.42.

fought and seized their vital cargo of timber.[5168] The constant seizure of wood was devastating to Egypt, for it deprived it of the one essential ingredient for ship construction in an age when shipping played the primary economic role. Timber was also crucial for other basic economic activities in Egypt such as transport, irrigation, and construction, which all collapsed following the loss of supplies.[5169] This fulfilled the papacy's prediction that if these items failed to reach Egypt, it would break the country's military power and shatter the prosperity of the population.[5170] The Mamluks spent more for their defence at sea, and sought materials through escorted expeditions to the Anatolian coasts, but this bled them financially.[5171] Drained East in the Indian Ocean, and West in the Mediterranean, Mamluk Egypt, eventually, was undone, but not due to her lack of business acumen,[5172] as mainstream history claims.

The Portuguese destruction of Islamic eastern trade is interpreted positively by many, such as Chaudhuri, who, passing in silence over the facts just seen, instead, writes:

> 'There is no doubt that in setting up an administrative structure in the capital city of Goa and in other lesser possessions and in exercising a quasi political control over the Indian ocean traders to the West of the Malacca strait, the (Portuguese) Estado da India was being highly innovative.'[5173]

Chaudhuri hails Portuguese accomplishments:

> 'How was it possible for a small and relatively obscure nation facing the Atlantic and outside the brilliant economic mainstream of Mediterranean to achieve such status? Contemporary Portuguese historians and chroniclers depicted the early fidalgos in the east as belonging to a heroic band of conquistadors, comparable to the great Spanish soldiers in the New World.... The key to Portuguese success in the Indian Ocean lay in the military valour of Christian warriors sanctified by divine blessing.'[5174]

[5168] Priuli; Paoli, in W. Heyd: *Histoire*; op cit; p. 538.
[5169] W. Heyd: *Histoire*; op cit; p. 24.
[5170] Ibid.
[5171] I.M. Lapidus: *Muslim Cities*; op cit; p. 35.
[5172] Ayalon in J. L. Abu-Lughod: *Before European Hegemony*, op cit; p.244.
[5173] K.N. Chaudhuri: *Trade and Civilisation*; op cit;p.71.
[5174] Ibid; p.77.

Ashtor, too, praises: 'the daring and the ability of the Portuguese.'[5175] Like most modern historians, he sets aside other factors, and blames the collapse of Islamic trade and prosperity on the Mamluks, saying that:

> 'The Mamluks were foreigners ruling over millions of people who were excluded from the higher ranks of the feudal hierarchy. They had no interest in developing the economic forces of their countries. So their rule degenerated into reckless exploitation, which ruined once flourishing countries.'[5176]

And

> 'The foreign slaves who had become the lords of Egypt and Syria did their utmost to enrich themselves as soon as possible.'[5177]

And

> 'The Mamluk authorities employed this method of extortion time and again, even acquiring the goods by compulsory sale at cheap prices.'[5178]

And so to the final paragraph of his book:

> 'This was the end of what had once been the flower of civilisation in Western Asia and the Mediterranean world. The flourishing economy of the Near east had been ruined by the rapacious military, and its great civilising achievements had been destroyed through inability to adopt new methods of production and new ways of life.'[5179]

The Arab historian Charles Issawi goes one step further, blaming Muslims for their 'ineptitude' to trade, which as he says 'was to do with the social structure of the region.'[5180] Even more disparagingly towards the Muslims, he cites Mantran, who holds:

> 'One aspect of the decline in moral standards was the arrogance of Muslims towards other faiths and cultures... Their lack of curiosity and their parochialism born of a feeling of superiority, may be measured by the tiny number of Muslim travellers to Europe in the 16th –18th centuries and by noting that the Turks and Arabs did not think of going to infidel lands for trade, at most allowing the Europeans to come to them.'[5181]

[5175] E. Ashtor: *A Social*; op cit; p. 330.
[5176] Ibid; p. 280.
[5177] Ibid; p. 283.
[5178] Ibid; p. 320.
[5179] Ibid; p. 231.
[5180] C. Issawi: The Decline of Middle Eastern Trade; in *The Global Opportunity*, ed by F.F. Armesto; op cit; pp 133-154. at p. 154.
[5181] R. Mantran; Istanbul; p. 604 in C. Issawi: The Decline; op cit; pp. 140-1.

Which, of course, is historically untrue, for, as just amply shown, and also as demonstrated in the first part of this work, no nation traded as widely as the Muslims did, going as far as China, and establishing trading colonies in India, Ceylon, the East Indies, and China, and earlier than any other nation, as early as the close of the 8th century.[5182] The Muslim merchant, before anyone else, crossed the long distances, by sea, and also through the deserts, via caravans, in pursuit of trade. He did so in times when Tartars, robbers, murderers, Mongols, crusaders, and pirates infested his route. The Muslim merchant was aware, Rosenberger notes, of the risks taken in seeking fortune in distant places, through dangerous roads, yet some business trips were astonishing.[5183] In China, Ibn Battuta came across merchants not just from India, but also from as far as Ceuta in Morocco.[5184] It is neither true that the Muslims did not want to establish a trading presence in the West. They were, as Denett insists, very keen on it, but were prevented from doing so as early as the time of Charlemagne in the 8-9th century.[5185] Until the 19th century, the Muslims were prevented from establishing a merchant presence north of the Mediterranean through pillage and slaughter of merchants on the high seas and in their quarters on the coast of Europe.[5186] The same slaughter and pillage was also adopted to remove their presence from anywhere on the Indian Ocean.

[5182] W. Heyd: *Geschichte; op cit;* Vol 1; p. 28.
[5183] B. Rosenberger: La Pratique du Commerce; op cit; p. 250.
[5184] Ibid.
[5185] D.C. Denett: Pirenne and Muhammad, in *Bedeutung;* op cit; pp. 120-59; op cit; at p. 125.
[5186] L. Valensi: *North Africa*; op cit; pp. 54 ff.

Final Words:

By 1650, Muslim North Africa was becoming economically impoverished as the Trans-Saharan traffic, which had sustained it, was diverted to European vessels operating along the Atlantic coast of West Africa.[5187] In the Mediterranean, corsairs bearing the cross attacked Muslim boats relentlessly, in 1764, catching 204 vessels (Algerians, Tunisians, and Tripolitans); 2 in 1770; 94 in 1775; 240 in 1780; and 157 in 1785.[5188] Elsewhere, along the east coast of Africa, in the Indian Ocean, Christian piracy caused Islamic cities to disappear, while Muslim shipping of the Red Sea, the Gulf, and Hadramut was reduced to an unimportant traffic.[5189]

Thus, by the time the modern colonial powers (England, France and Holland) arrived in the region, whether in the Mediterranean, or in countries bordering the Red Sea and Indian Ocean, they found moribund places and societies. Colonisation only made a bad situation worse. As Toqueville acknowledged in 1847 on the French colonisation of Algeria (from 1830):

> 'Everywhere we have laid our hands on the revenues [from pious foundations providing for charity or education], largely diverting them from their original purpose. We have cut down the number of charities, let schools fall into ruin, closed the colleges. Around us the lights have gone out, the recruitment of men of religion and men of law has ceased. We have, in other words, made Muslim society far more miserable, disorganised, ignorant and barbarous than ever it was before it knew us.'[5190]

And when they left, the colonisers bequeathed to us the chaotic and backward Muslim societies of today.

[5187] A. R. Lewis: *The Islamic World*; op cit; Epilogue.
[5188] L. Valensi: *North Africa;* op cit; p. 48.
[5189] A. R. Lewis: *The Islamic World*; op cit; Epilogue.
[5190] C. Ageron: *Modern Algeria*, tr by M. Brett (Hurst and Company, London, 9th ed, 1990), p.21.

CONCLUSION

Early Islamic civilisation (7th-13th century) contributed extensively to the rise of modern science and civilisation. Islam, the faith, which today is equated with violence, intolerance and barbarism, was the very basis of such cultural and scientific upsurge.

Islamic civilisation might have had its few instances of tensions between the Muslim majority and the Jewish and Christian minorities, but, on the whole, it was a model of tolerance, where racial prejudice and persecution of minorities, due to difference of creed or ethnicity, had little place. All faiths, together, were protected in their rights and possessions, their beliefs and their laws, thrived even at times when Islam, during the Mongol and crusader invasions (1096-early 14th century), was on the verge of extinction as an entity. There was no extermination of any entity on the ground of its ethnic, racial or religious background, or due to the threat such entity posed to Islamic 'purity' or 'unity'.
Beyond survival, all faiths participated in the Islamic civilisation. They played a full and whole part in it, with Christians and Jews, alongside Muslims, as ministers, ambassadors, scholars, and tradesmen, building together a civilisation during centuries Western history tells us were 'The Dark Ages.' This unique harmony survived until invasions ripped the whole thing apart, and left it in tatters to this day. And history today, conveyed to us generally by writers hostile to Islam dressed in academic clothes, rips up the realities of this Islamic civilisation still further.

Early Islamic civilisation remains to this day the greatest model of all. A great model because, fundamentally, Muslim civilisation scorned the notion of one race being superior to another, and that civilisation was for all, by all, together. And in this respect, modern 'civilised' nations will have to labour far harder just to comprehend this fact, admit it in the writing of their history, and live by it.

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During the Golden Age of Islamic Civilisation the Islamic world led in practically every area of knowledge and culture. In it people from every race and every creed, from Spain to China, travelled, traded and built up sciences, all living under the protection of Islamic law. Public libraries, observatories and universities were born in Islamic Civilisation all emerging from the mosque as the centre of learning.

The contrast with the situation today is dramatic and begs for explanation. This has been the subject of much debate and propaganda which has unfortunately left a legacy of distortions and misunderstandings.

In particular, the rise and achievements of Islamic Civilisation are often separated from their Islamic inspiration while its decline is blamed in various ways on the religion.

Al-Djazairi refutes this and related distortions and provides the reader with a wealth of fascinating material describing the development of trade, industry and science in the Islamic world and what caused their rise and decline.

Dr Salah Eddine Zaimeche Al-Djazairi has lectured and researched at the University of Constantine, Algeria for more than ten years. He has also worked recently at the University of Manchester(UMIST) in the field of the history of science.

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The cover image is of Al-Azhar Mosque in Cairo home of one of the oldest universities in the world and the reputed centre of Muslim legal authority.

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